THE IMPACT OF A MOCK EXAM ON UNDERGRADUATE CONTRUCTION MANAGEMENT STUDENT PERFORMANCE ON THE NATIONAL ASSOCIATE CONSTRUCTOR CERTIFICATION EXAM

A Dissertation Presented to the

Faculty of the College of Education

University of Houston

by

Lana Kay Coble, CPC

December 2015

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A Dissertation for the Degree
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Dedication

My inspiration to succeed in life and pursue my doctorate degree came from humble beginnings—my father (Gerald) and mother (Iris). Both were born in small rural communities shortly after the Great Depression. My father was a self-made man, succeeding in building a business after serving his country in the Korean War. His highest educational accomplishment was a GED, but he continually urged me to pursue my education to the highest level I desired. My mother completed business school to become an administrative assistant to high-ranking officers in the oil and gas industry. Both share the characteristics of emotional intelligence, persistence in their endeavors, and accomplishment in their craft. While my father passed away far too early in my life, he has been with me every moment of my studies. My parents' love and belief created the foundation for this accomplishment so it is fitting that this work is dedicated to them both.

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An Abstract of a Dissertation Presented to the
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In Partial Fulfillment
of the Requirements for the Degree

by

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Abstract

This research assessed whether a relationship existed between the independent variable of a mock exam pass/fail grade and the dependent variable of the American Institute of Constructors' (AIC) associate constructor (AC) certification exam pass/fail grade. The mock exam was reviewed by the Construction Certification Committee (CCC), who conducted a cursory review and determined that the mock exam exhibited face validity. Retrospective quantitative data were analyzed to assess the effectiveness of a mock preparatory exam to ready students for passing the AC National Certification exam administered as an exit requirement for a public university Bachelor of Science (BS) degree in construction science. The mock exam was administered prior to structured test preparation activities for the purpose of providing a pretest, with the actual certification exam serving as the posttest. Data evaluation did show that students who completed the mock exam passed the AIC certification exam with statistically significant results. This body of research includes test preparation techniques employed specifically for the AC National Certification exam, construction management education, and statistical analysis of mock exam pretest and posttest, which span two semesters of collegiate study.

Keywords: norm referenced, criterion test, high stakes testing, retest effect, quasi experimental design, exit exam, pretest posttest design, construction management education, test preparation techniques

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Chapter I

Introduction

As described in the abstract, this research is based on an analysis of test preparation effectiveness through participation in a simulated (mock) exam for AC Level 1 certification. Research subjects were senior students in the construction management program at a public university, which is also a host site for administration of the exam. Before the scope of this research can be described, it is critical to understand the contextual relevance of licensure vs. credentialization, the agency that designs the AC exam and its relationship to academic accreditation for the program where the exam is administered, and the scope of the AC certificate.

Context

Licensure vs. Credentialization

Understanding the distinction between licensure and certification is also critical to the context of this research. In the construction industry, licensure is required by architects and engineers to practice design and is awarded to individual practitioners who have passed the rigorous state exam. The requirements for becoming licensed include completing a bachelor's degree in the field of practice, working for a specified period under a licensed practitioner, and successfully completing extensive testing administered by a professional board. Licensure is granted at the state level of government and enables the successful practitioner to be designated as a registered architect or professional engineer in a legal context. The necessity for government issuance of licenses is based upon the need to protect the public from faulty design, which could potentially invoke

harm to the building inhabitants. It should be noted that architects and engineers are required to acquire and maintain their license status in all 50 states in the United States.

In comparison to fellow professionals—architects and engineers—the approach toward licensure for construction professionals is aimed at company licensing of general contractors in lieu of individual construction managers. This myopic approach, which excludes verification of skill sets by individual construction practitioners and focuses on local building code requirements, can create inconsistency in performance, which erodes the public trust in safe and effective construction methodologies. Thus the need for individual construction professional certification was born in an effort to earn the trust of building inhabitants, create a higher level of practice, and promote the stature of the professional constructor.

Certification and licensure are similar in that they both require the demonstration of a level of knowledge or ability; however, their differences are significant. Certification is administered by a professional association and does not carry the legal context of licensure. Not all certifications are an acknowledgment of educational achievement or are issued by an agency appointed to safeguard the public interest; some certifications are specialized skill sets that support a microcosm of continued professional development. Certification attainment will vary from each administering agency in terms of the complexity, rigor, and length of the exam required. Another distinction between licensure and certification is that licensure is mandated by state law while certification is a voluntary choice by the construction professional.

The emergence of certification for construction managers is a relatively recent movement within the industry, and there are currently more specialized certificates offered as compared to those that test broad baseline skill sets required of a construction project manager. The baseline skill sets are basic knowledge and skills embodied in procedures that must be demonstrated by the construction professional in order to execute a project safely, efficiently, and effectively. The AC qualifies as a broad-base certificate for entry-level construction managers, embodying 10 basic knowledge areas.

American Institute of Constructors (AIC), Construction Certification Commission (CCC), and American National Standards Institute (ANSI) Accreditation

Founded in 1971(Alungbe, Steppe, Li, & Zagari, 2008), the AIC is a national organization that administers the associate constructor (AC) certification and certified professional constructor (CPC) exams on a biannual basis to approximately 2,500 candidates annually. In recent years, the CCC has reported exam registration from 2012 through 2014 to fall to an average of 1,568 examinees per year. The CCC was founded in 1996 by the AIC and operates as a semi-autonomous agency for the purpose of certification exam administration. Construction professionals and educators contribute to the standards maintained by the AIC and CCC through question contributions for the annual exams. Test questions are reviewed for acceptance by administrative committees within the CCC and are rotated randomly between exam periods in order to reduce inflated test scores through familiarity of content. While construction professionals are encouraged to submit up-to-date relevant test content, the CCC has established conflict of interest policies for members and questions are randomly selected from a large database,

each test period, to ensure the integrity required for administration of the certification exams.

This initiative is motivated by the desire of a society of construction professionals (AIC) to establish standards and achieve status similar to their architectural and engineering counterparts. Certification is intended for the purpose of verifying the skills and knowledge required to manage complex construction processes. Credentialization is achieved from passing either exam with a cut score of 70% or greater and is currently offered to 69 universities that offer a BS degree in construction science (AIC, 2014) across the United States (Appendix D). The primary differential distinction between certificates is industry experience; whereas the AC is intended for students graduating from an accredited 4-year construction management program, the CPC requires at least 8 years of industry experience in the capacity of project manager or construction executive.

To reinforce the legitimacy of the AIC and CCC, both groups gained ANSI accreditation in 2014. ANSI is a 501(c) 3 not-for-profit organization, formed in 1918, that accredits personnel certification programs based on the International Standard ANSI/ISO/IEC 17024. The International Organization for Standardization (ISO) released ISO/IEC 17024 in 2003 and is designed to synchronize the personnel certification process on a global level with 52 current programs and 220 certificates (Appendix C). The elements included within the 17024 standard indicate that certified programs must perform as follows:

- Define the competencies to be examined.
- Define knowledge, skills, and personal attributes required for certification.

- Provide independent examinations.
- Ensure a valid test of competence via the examination for certification where competency is described as “the demonstrated ability to apply knowledge, skills and attributes.”

ANSI conducts accreditation of certification programs that assess conformance to standards and include differing industrial sectors, not-for-profits, large multinational corporations, and government agencies, and approximately 1 million professionals hold certifications from organizations accredited under ANSI's personnel certification programs.

American Council for Construction Education (ACCE), Council for Higher Education Accreditation (CHEA), and the AC Level 1 Exam

The AIC is affiliated with the ACCE, which was founded in 1974 and is recognized by the Council for Higher Education Accreditation (CHEA) as the program responsible for accrediting 4-year construction science programs in the nation. In 2014, ACCE reported 73 accredited 4-year construction science programs in the United States (ACCE, 2014; Appendix C). Comparison between ACCE approved programs and AC Level 1 exam administration university sites reveal a common cross section of 63% and 66%, respectively. While a national quality ranking of construction management programs does not exist, experts in the field would concur that many of the common programs shared by ACCE and AC are among the top in the United States. The high percentage of common programs and test administration institutions, in addition to

expertise assessment of participant universities infers alignment and strength between the ACCE and AC Level 1 certification exam.

Associate Constructor (AC) Certification

This credential is considered an entry-level qualification for a graduating student of an accredited construction management program or a construction professional with minimal experience and is commonly referred to as the Level 1 Certification. The 300-question exam allows 8 hours for completion within a single 9-hour period and includes 10 knowledge concepts that are essential fundamentals for a beginning practitioner. The 10 concepts vary in quantity percentage for the exam (i.e., one concept is 10%, while another is 4%, etc.) and the subjects are as follows:

- Communication
- Engineering Concepts
- Management Concepts
- Materials, Methods, and Project Modeling
- Bidding and Estimating
- Budgeting and Cost Control
- Planning and Scheduling
- Safety
- Surveying and Geomatics
- Project Administration

While percentile comparison rankings are reported for all applicants taking the exam, certification is based upon a pass/fail result of 70% or better. This pass/fail grade equates to achieving 210 correct answers to the 300 questions.

Applicants must register and receive approval from the CCC to qualify to take the exam and be classified as a senior or one year post graduation from an accredited construction management program or meet 4 years of industry experience. The current fee for taking the exam is $165 for the first test and is then reduced to $110 for subsequent exams in the event the examinee fails to pass the exam on the first attempt. The exam is offered twice a year and actual questions rotate between exams to guard against achievement through test familiarity.

Research Scope

As with any effective research project, it is essential to eliminate what is not included prior to isolating the actual content. From the contextual description provided, the research for this project excludes the following:

- criterion testing as it relates to professional certification;
- the merit of exit exams as they relate to a degree from an institution of higher education;
- evaluation of differing options for exit testing by certification agencies;
- evaluation of preparatory programs for certification exams; or
- evaluation of differing construction management certification programs.

While each of these topics has merit, the researcher has chosen to exclude these areas of investigation in order to focus on preparation for the AC Level 1 exam, specifically the administration of a mock AC exam, to determine if there was any benefit to students in their attempt to pass the AC Level 1 exam when compared to students who chose not to participate in the mock exam. The mock exam was prepared by the researcher while teaching as an associate professor in a major public university construction management program. While the researcher had qualified as a CPC during the time of this research, there was no access to actual AC Level 1 test questions. Content for the mock exam was derived from exposure to the 800+ page AC study guide and through creation of original problem questions that addressed the exam's 10 criteria. As previously stated, the researcher received a review of the mock exam content by the CCC testing committee to assure face validity. The researcher was also responsible for teaching the construction principles related to the exam criteria to senior students in the capstone course for the program. Similar to many research efforts, this project was born out of necessity to improve passing scores by first-attempt exam applicants. Students generally found the AC study guide to be overwhelming as reference material, especially since the time period between registration and taking the exam was approximately 12 weeks. The mock exam concept was initially developed to aid the student in focusing on areas of weakness, which would translate into higher efficiency during the exam preparation phase. The secondary intent of the mock exam was to re-create the exam process as closely as possible, similar to SAT preparation exams, which could facilitate a reduction in test-taking anxiety. Theorization of secondary obstacle removal from the testing experience

(i.e., anxiety from high stakes testing) fostered the belief that the content of the exam would remain as the primary focus and facilitate better results. Refer to Appendix A regarding Internal Review Board Approval to conduct this research within current ethical practices.

Research Context and Timing

This research study was conducted in a southern US, state-funded, public university that provides a construction program culminating in a BS construction management degree. The university also serves as a testing site for both the AC and CPC certifications on a biannual basis (fall and spring). The degree requires completion of 120 hours of face-to-face coursework and includes a minimum of 400 hours of internship with an approved construction firm. The construction program has a brief history, starting in 2007 in its current configuration, and has quickly grown to 400+ students. The AC certification exam was initially offered as voluntary to seniors in the capstone course in the fall of 2010. The following semester, the decision was made by the program director to require acquisition of the AC Level 1 certification prior to graduation from the program. Requiring the AC test as an exit exam for first-semester senior students in the first of two capstone courses allows those students who fail the exam an additional semester to complete the exit exam. The researcher was engaged in student preparation for five continuous semesters, fall 2010 through fall 2012; however, the mock exam was not introduced until the spring of 2012 and was offered for two semesters. In order to reduce the testing threat from participation in the mock exam and preserve the capability of the mock exam to expose students' conceptual knowledge weaknesses, it was

determined that the mock exam would be administered to the experimental group prior to the formalized preparation period included in the capstone course. The number of students who participated in the voluntary mock exam was 64% of the total AC examinees for both semesters. A further point of consideration that contributes to the high stakes aspect of the exam is that the registration fee was the responsibility of the student for the initial exam and retest if required.

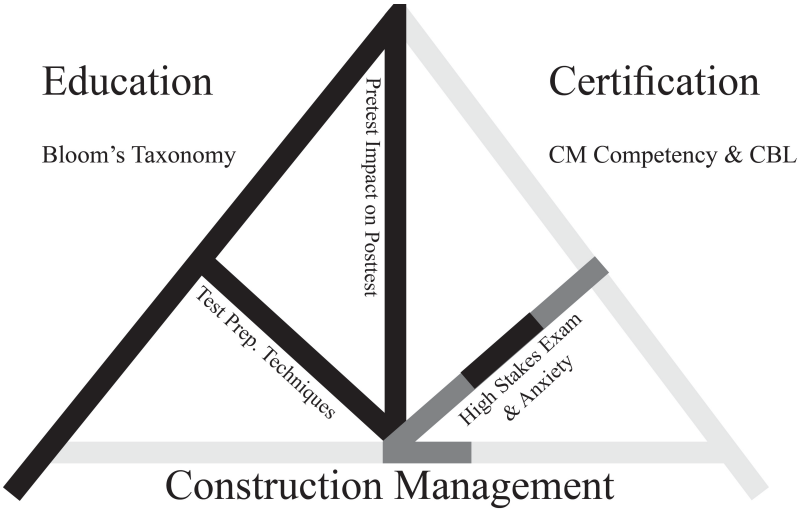

Figure 1. Research Core Concepts—Literature Review Model

Research Core Concepts

While there has been a considerable amount of research conducted regarding high stakes exams, there have been minimal studies where construction management education and high stakes testing converge. Extensive research has been conducted on the effects of standardized testing and subsequent academic performance, but little was found on the relationship of pretesting via a mock exam and

its effect on the actual exit exam. When considering the context of the research study, the content discipline, and the methods utilized in this project, there were four predominant concepts, which emerged as illustrated in Figure 1. Construction management education, specifically the content of the exam and the concepts that are considered globally important to performance as a construction professional, forms the platform for this study. The three supporting aspects that facilitate this research are high stakes testing, the use of a mock exam as a means of test preparation, and pretest vs. posttest methodology. Each of these concepts will be explored thoroughly in subsequent sections of this dissertation as well as their relevance to providing a stable and solidly conducted study. The primary intent is to reinforce the body of knowledge in the construction management discipline and possibly improve the related pedagogy to impart learning. Secondarily, other exam preparation techniques that are suited for construction management content learning will be described so that other academicians may receive beneficial use.

The Problem

Poor AC Level 1 Exam Passing Rates

As previously described, the AC certification exam was required for two semesters prior to implementation of the mock preparatory exam. Overall performance by first-semester senior students was consistently below the national average of examinees. Initial investigation of possible poor performance indicators included a survey of faculty members to determine the extent to which exam content was taught during class periods. While study guide materials were distributed to the faculty to reinforce subject content in

the classroom, the results of overall test performance were below standards considered acceptable by the program director (70% pass rate).

Inconsistent Pedagogy

Additional concern was focused on the probability of inconsistent pedagogy due to the high count of adjunct faculty. During the five-semester period, from fall 2010 through fall 2012, there were three full-time faculty and 13 adjunct faculty members to teach approximately 27 classes per semester. While the university was located in an area rich with professional expertise that was conducive to adjunct faculty, it was important to bridge the pedagogical gap created by turnover in faculty. Subsequent evaluation posited the question of how to provide additional preparation methods without compromising actual AC Level 1 exam content.

High Stakes Exam Anxiety

Lastly, from the inception of the AC Level 1 certificate mandate prior to graduation, a considerable degree of anxiety was voiced by the construction management student body, which created the need to lower test anxiety.

Hypothesis

Hypothesis

Students who take the mock exam experience a statistically significant improvement in passing scores on the AC Level 1 certification exam as an experimental pre to post exam group.

Null Hypothesis

There is no significant improvement on passing scores from the mock exam to AC Level 1 certification exam by students who took both exams. This research attempts to determine a relationship of the independent variable (mock exam pass/fail grade) on the dependent variable (actual AC Level 1 certification exam pass/fail grade). Evaluation of retrospective quantitative data from student performance on the mock exam will be utilized to assess its effectiveness as a preparation tool for the AC Level 1 certification exam.

The research subjects were students enrolled in the first-semester capstone course of their senior year, in which the AC Level 1 exam was a requirement, represented 40% of their grade for that class, and was mandated as a prerequisite toward obtaining their B.S. degree in construction management. The experimental group for both semesters included in this study consists of those students who voluntarily completed the mock exam, which was administered on campus on the second Saturday of each semester. As noted earlier, the mock exam was administered before structured classroom preparation activities commenced and was proctored under the same conditions of the actual AC Level 1 exam with exception to the test delivery means. Since Scantron was not available for use to simulate the actual AC Level 1 exam, the researcher delivered the mock exam via Blackboard. By implementing Blackboard as the platform for the mock exam, the security permissions to the system were configured so the questions were only available during the exam, preserving the integrity of the content for future use. The control group for the study consisted of students who chose not to participate in the mock exam and

took the actual AC Level 1 exam at the same time during the semester, as did the experimental group. The research design of the pretest and posttest is comprised of the mock exam and actual AC Level 1 exam, respectively. Quantitative data is collected from both exams on the pass/fail grade by each participant during the two semesters of the study and then analyzed to determine whether there is significant evidence to verify the research hypothesis. The researcher made every attempt to emulate the actual AC Level 1 exam in order to increase validity, with a few minor concessions, which are detailed fully in the methodology section of this dissertation.

As stated in the research concepts, a secondary goal is to facilitate other exam preparation techniques that are suited for construction management education, so qualitative input was obtained from students in the experimental group at two significant periods during the semester, the first being post mock exam and the other post AC Level 1 exam. Input was also requested by the control group at the completion of the first capstone course on the AC Level 1 test preparation method employed by the researcher during the semester. The combination of qualitative data, via student surveys, and quantitative data, via pass/fail grades on pretest and posttest, creates a quasi-experimental research design.

Definition of Terms

The terms defined below are considered to be relevant to the research presented in this study. Terminology is presented that is within the education or construction vernacular and may be unfamiliar to the average reader.

AC Level 1 Certification Exam

The conceptual definition is a 300-question, entry-level construction certification exam administered over an 8-hour period for the intent of granting the examinee that passes a certification as an associate constructor (AC). The exam is composed of 10 constructs, scored by Scantron, and is administered by the CCC. The operational definition is a pass/fail exam based upon 70% of questions answered correctly (210 out of 300). The AC Level 1 exam is proctored on campus, in a classroom, with professor oversight, on a Saturday during the fall or spring semester. Questions are rotated from a question data bank each semester in an effort to reduce test familiarity as a confounding variable.

Mock Exam

The conceptual definition is a simulation exam of the AC Level 1 exam designed and administered by the researcher, utilizing Blackboard as the mode of delivery. The knowledge tested is from the same 10 constructs from the AC Level 1 exam but the percentage of content constructs varies. The variation in constructs percentage will be discussed in the chapter on methodology. Another difference between the mock exam and AC Level 1 certification exam is participation by the study subjects, where the mock exam is voluntary and the AC Level 1 is mandatory. The operational definition is a pass/fail exam based upon 70% of questions answered correctly (210 out of 300). The mock exam is proctored on campus, in a classroom, with professor oversight, on a Saturday during the fall or spring semester. While there were only 300 questions

designed for the mock exam, students were not allowed access to the questions after taking the exam to reduce test familiarity as a confounding variable.

Geomatics

This is the science that applies mathematical methods to Earth's surface data, with specific construction reference to land surveying and soil excavation calculations.

Bloom's Taxonomy

Bloom's is a foundational system for educators in establishing learning objectives for student learning. The original classification system was developed in the 1950s and was based on a progression of objectives starting with knowledge, comprehension, application, analysis, synthesis, and, finally, evaluation. In the 1990s the objectives were modified to move from nouns to verbs and progress from remembering, understanding, applying, analyzing, evaluating, and creating.

Learning and Study Strategies Inventory (LASSI)

LASSI is a 10 scale, 80-item diagnostic assessment that illuminates a student's ability, attitude, and beliefs regarding study skills and strategies. The instrument of measure was developed by Weinstein, Schulte, and Palmer at the University of Texas and is a statistically valid and reliable diagnostic tool. Many universities in the United States utilize this assessment as a means to assist students in developing self-awareness of their study skills.

Competency Based Learning (CBL)

CBL is utilized in universities and professional environments as an alternative to course-based curriculum for the purpose of developing competencies that are useful in the workplace. According to Voorhees (2001), competencies are achieved through the integration of skills, abilities, and knowledge in learning bundles, which relate to desired professional performance.

Chapter II

Review of Related Literature

Construction Management Certification

This portion of the literature review concerns the table top from Figure 1 and 2, construction management certification and education.

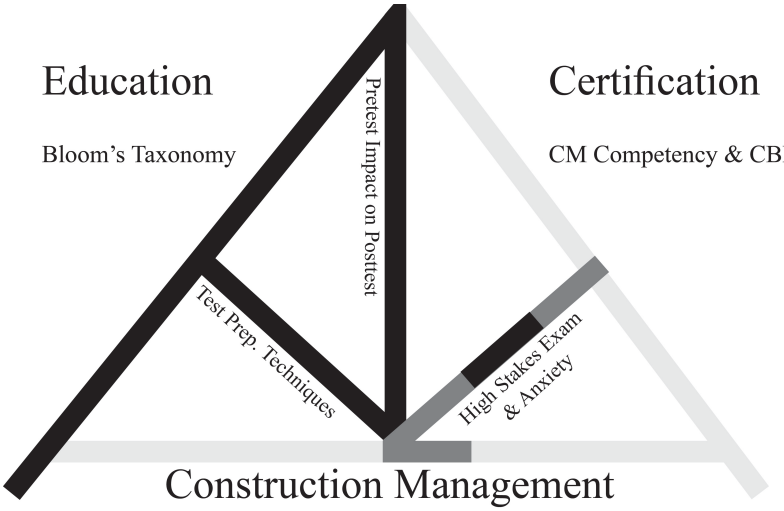

Figure 2. Construction Professional Certification and Construction Management Education—Least Amount of Literature

The research to date on the combined topics of construction education and certification are limited since certification agencies have been in existence for a relatively short time period, as described in the introduction. As a result of scarcity of information, the literature review includes information regarding introductory certification from a variety of industries, i.e., industrial technology, pharmacy, nursing, and vocational technology programs. The focal point of this cross-sectional review approach was to glean commonalities regarding certification from various industries and compare them to construction certification. While researching industrial technology certification, Field and

Rowe (2001) included the work of Barnhardt (1994), where 450 multidisciplinary certification programs (out of 1,500) responded to the research query, were reviewed and determined that a singular definition will not apply to every certification due to the technical differences. However, commonalities exist in that applicants are considered based upon education and experience. While the only project management certification that existed at the time of Barnhart's study was the Project Management Professional (PMP) certification, the combination of qualifications in education and experience are common with construction industry certifications today, including the AC Level 1.

Research for the literature review of this study failed to locate any updated accounting of current certification programs offered in the US. Jafferson (2001) asserted that certification provides recognition of achievements within a profession based on requirements adopted by its representative association, and review of the literature indicates this definition of certification is common to most certification agencies. Barnhardt (1994) prescribes that competency-based exams require examinees to prove their expertise by mastering a common body of knowledge within their profession in order to attain certification. Pare (1996) takes the certification concept further by stating certified individuals may be the best indicator of qualifications in the workplace. An added dimension of a certified professional's capability was asserted by Jaffeson (2001) when he stated, "Credentials and competency exams imply that individuals are guaranteed to perform at certain prescribed levels" (cited in Field & Rowe, p.7). Barnhardt (1994) does not share Jaffeson's assertion of a guarantee in performance as a result of obtaining certification and specifically states that it is not a predictor of

performance. Remer and Martin (2009) researched eight major project management certificates related to construction in the United States and concluded that ". . . certification is evidence that the holder has a certain minimum level of competence in the subject area" (p.177).

Most of the certifications reviewed in the literature converged on the perspective expressed by Remer and Martin (2009) and reflect commonality of most certifications. Barnhardt (1994) provides further clarification on the distinction between certification and licensure, which are common across industries, indicating that certification is voluntary, providing assurances about an individual professional; and licensure is a state-managed standards program that restricts participation of individuals in a profession who meet minimum requirements. This understanding between licensure and certification are commonly agreed upon across professional practice within the United States and abroad. Barnhardt (1994) further suggests that certifications can imply an individual's dedication to his or her profession, provide an assessment tool regarding content knowledge, provide resources for training, and provide a vehicle for maintaining competency in a profession. Peluso (2000) postulated that certification programs would provide public confidence based upon consistency in the quality of work afforded to certificants. Field and Rowe (2001) reference the writing of Everett Israel (2000) regarding the use of certification exams to assess technical aspects of industrial technology baccalaureate programs. While this reference was specific to industrial technology, the concept of utilizing exit exams or certification exams as a measure of learning in academic programs is not uncommon. At the time of this research, the AC

Level 1 exam is administered to 67 university programs to varying degrees of significance to the student's status in the degree program. The public university where the research was conducted is currently ranked second among all participating institutions with regard to examinees seeking AC Level 1 certification.

In order to understand the relevance of the AC Level 1 certification and its content, a comparison is necessary to current-day practitioners' viewpoint on construction professional certification and associated content. Research on professional certification in the US construction industry, for a 5-year period starting in 2003 (Alungbe, Stepp, Li, & Zargari, 2008), supports the premise that successful performance on certification exams provide recognition that the professional can perform at a standard level of proficiency mutually agreed upon by fellow constituents. While other certifications were examined by Alungbe et al (2008), the AC Level 1 exam was considered a test of ability for construction fundamentals, which supports the CCC's definition of exam content. Interestingly, Alungbe et al. (2008) purport that certificants comprise a diverse background ranging from construction trades, college construction management programs, or other career choices. AC Level 1 exam requirements allow for the experience track, 4 years of approved experience by the CCC; however, the focus for this research study is aimed at those examinees who qualified via the educational track of completing a 4-year accredited construction management program. Clarification of the sequencing of the exam and credentialization via the educational track is as follows: The examinee must be within a year or two semesters of graduation from an accredited

program and upon passing the exam and providing proof of graduation, the young professional will be granted AC Level 1 certification.

Essential content knowledge and the means of acquiring knowledge within the construction industry were studied by Edum-Fotwe and McCaffer (2000) by surveying project managers in the UK. Since knowledge and skill sets for construction are generally considered universal, with exception of technology application systems, the study provides an interesting comparison to the skill sets included in the AC Level 1 exam. Of further interest is the information acquired from respondents on how the knowledge was attained and classified through academia, professional development training (post academia), and experience. The distinction of knowledge transference provides an added dimension of understanding those skill sets, which are tested via the AC level 1 exam vs. other certifications that require additional experience prior to examination. In an effort to illuminate the contextual dimension of skill sets and their relative career timing acquisition, the researcher applied the 10 core skill sets of the AC Level 1 exam to applicable portions of Edum-Fotwe and McCaffer's (2000, p.122) findings, as shown in Table 1.

Table 1. Comparison of AC Level 1 Exam vs. Edum-Fotwe and McCaffer (2000) Project Manager Skill Sets

Project Manager Skill Sets[a] Construct		**Method of Construct Acquisition Index[b]**		
#	**Description (AC%)[c]**	**Academic Study**	**Professional Development**	**On the Job Experience**
1	Communication (5.5%)	6.1	22.9	71.1[d]
2	Engineering (9%)	21.8	10.9	67.3[e]
3	Management Concepts (4%)	0.9	13.6	86.4
4	Materials, Methods, & Plan Reading (10%)	21.8	11.8	81.8
5	Bidding & Estimating (17%)	2.7	11.8	74.5
6	Budgeting, Costs, & Cost Control (10.5)	5.9	12.3	68.6[f]
7	Planning, Scheduling, & Control (16.5%)	3.6	13.6	77.3
8	Safety (7%)	1.8	22.7	55.5
9	Surveying and Project Layout (Geomatics) (2%)	0.0	0.9	82.7
10	Administration (18.5%)	4.0	12.7	65.8[g]

a. Constructs listed are common to both the AC Level 1 certification exam and Edum-Fotwe et al., 2000.
b. Index from Edum-Fotwe & McCaffer (2000) and represents knowledge and skill factor between 0 and 100, with 100 representing the highest value by respondents.
c. Percentages of constructs are per those in effect at the time of the research study.
d. Indices for the communication construct are an average of four survey skills identified by respondents in Edum-Fotwe et al., 2000.
e. Indices for the engineering construct are an average of two survey skills identified by respondents in Edum-Fotwe et al., 2000.
f. Indices for the budgeting construct are an average of two survey skills, forecasting and cost control, identified by respondents in Edum-Fotwe et al., 2000.
g. Indices for the administration construct are an average of five survey skills identified by respondents in Edum-Fotwe et al., 2000.

Of the core constructs, only two of them ranked above 10% by respondents as being achievable through academic study by a proficient project manager; those were (a) engineering, and (b) materials, methods, and plan reading. Since a majority of the examinees are seniors in an academic program, the inference relative to the AC Level 1 certification exam could be that the exam is suitable for entry-level construction professionals. While this is an interesting premise, primary importance to this study is focused on the overlapping constructs between the AC Level 1 exam and the skill sets supported by Edum-Fotwe and McCaffer (2000). The common knowledge and skill sets between opinions of construction professionals and AC Level 1 constructs provide face validity and appropriateness of the certification for junior-level construction professionals. Edum-Fotwe and McCaffer's (2000) most significant finding are as follows:

> . . . [it] has to be emphasized that for the dominant role of experience to be relevant for maintaining competency, this has to be built on a sound academic background. All the same, the evidence from the survey shows that academic programmes, although essential to acquiring project management competency, do not significantly contribute to maintaining and renewing the same to any appreciable degree. The over-reliance on experience for maintaining the competency of project managers means that they can miss out on the broader outlook, since most experience acquired will be specific. The high indices associated with the contribution of experience as perceived by project managers however, implies that

> making academic programmes in project management relevant cannot overlook the experience factor. (p. 123)

This finding supports the premise of strengthening academic learning by introductory construction project managers and the requirement of the AC Level 1 exam provides a checkpoint to verify construction management learning by the student. While the research from Edum-Fotwe and McCaffer (2000) illustrates the importance of experience in maintaining competency, this issue applies to a more advanced certification and doesn't apply to this study. It is important to note, however, that introductory experience is a requirement of the research participants as part of their curriculum during the third year in acquiring their B.S. in construction management (refer to Appendix B, Construction Experience CNST 3185). Enrollment in the construction experience class required successful completion of 400 hours working as an intern in a construction firm of either first- or second-tier level. The minimum tenure requirement, by the research subjects, provided exposure to the application of construction education concepts included in the undergraduate program and enabled introductory experience alignment with the AC Level 1 exam.

Accredited construction management curricula are a combination of construction techniques, application of engineering design fundamentals, and business management, which is in alignment with the degree program that the study participants were enrolled in (refer to Appendix B) and the 10 criteria of the AC Level 1 exam. The alignment between curricula and the AC Level 1 exam as well as accreditation approvals for both components is very important in establishing the validity of this research. The researcher

believes that this first gateway of analysis of the synchronicity of learning content in the university setting and the related testing must align in order for the research to continue. The findings of this comparison will be presented in the chapter on methodology. Lastly, Barnhardt (1994) suggests that evaluation of competency-based certification should contain the following four elements:

- examination entails a comprehensive body of knowledge related to task or job analysis,
- reasonable test control procedures are employed by a third party agency that is experienced in professional assessment,
- examination is recognized by a leading professional organization in the industry of certification, and
- qualification criteria shall reflect the importance of each in developing qualified professionals, i.e., academic education, job experience, and association involvement.

The AC Level 1 certification exam does contain all four elements of a competency test as described by Barnhardt, and is suitable as a certification platform for this research study.

Construction Management Education

According to Russell, Hanna, Bank, and Shapira (2007), construction management education was initially formalized in 1946 at Texas A&M University. Construction management education, when compared to other disciplines in higher education, is a relatively new endeavor. Comprehensive understanding of the roots and development of construction education must be accompanied with a broad perspective of

the industry it serves. Society has depended upon construction since the beginning of civilization for infrastructure, housing, and institutional and commerce facilities with the education for these skill sets provided through apprenticing from one generation to another. The industry has seen a sharp decline in recent years of the generational business model for contractors, both prime and secondary. While construction has existed for more than a thousand years, the novice observer may think that the occupation is changeless; however, construction methods change rapidly with the advent of new technologies. It is also significant to understand that construction management is an applied field, where both theory and application of how to construct facilities and infrastructure are required. The need to have some experience as an intern and that some of the instructors are actual practitioners is substantiated by the application nature of the construction industry. In addition, the current global economy and population growth has created a shortage of qualified construction management professionals. According to Abudayyeh, Russell, Johnston, and Rowings (2000),

> Construction graduates are currently in high demand by contractors of all types of construction, including residential, commercial, industrial, highway, and heavy construction. They are also in demand by design-construction firms and by large owners who have continuing construction programs. (p. 170)

The Bureau of Labor Statistics reported in December 2013 that the construction industry would account for $1,926 billion in 2022, an increase from 2012 actuals of $1,008 billion. This metric represents an annual growth rate of 4.1%, which is the largest

of any industry sector. The economic impact translates into a growth of construction jobs from 5.6 million in 2012 to a projected quantity of 7.3 million in 2022. The construction sector is also projected to experience the largest wage growth among all industries, surpassing healthcare, at 2.6%.

In addition to the rapid growth of the construction industry and subsequent labor shortages, the industry lacks cohesion across disciplines, geographic borders, and regulations. In their research on construction management education, Russell et al. (2007) included the following quote:

> Over 44,000 jurisdictions at the state and local government levels regulate building design, construction, and renovation through a confusing, diverse, and at times, conflicting array of codes, standards, rules, regulations, and procedures. Economies of scale, reduced life cycle costs, enhanced operating efficiencies achieved by other industries such as automobiles and aircraft, through the effective application of information technology to the design, construction, and operation of such products, have not been achieved in the United States construction industry. (Joachim & Wible, 2003)

The insight expressed by Joachim and Wible is shared by many construction professionals, as demonstrated by the recent initiative to standardize building design across a common platform through Building Information Modeling (BIM); however, the creation of unifying industry platforms requires time and can be unwieldy. Construction project characteristics vary significantly across and within sector types (i.e., hospitals,

infrastructure piping, nuclear facilities, etc.), but the processes to manage their construction are similar. The fragmented state of the construction industry is partially unified by the ACCE and AIC, with accreditation and certification programs that focus on process and non-project specific content. Content emphasis of these programs focuses on construction technology, management philosophy, engineering application, and industry practice. With the variances experienced in managing construction projects, problem solving and critical thinking are of significant importance since they are required on a daily basis. The steps involved in construction management critical thinking, devising multiple solutions, forming conclusions, synthesizing relevant information, and forecasting scenarios are aligned with the six cognitive categories from Bloom's Taxonomy, updated to reflect 21st-century learning (Overbaugh & Schultz, 2015), remembering, understanding, applying, analyzing, evaluating, and creating (Appendix G). The goal of Bloom's Taxonomy is intended to provide educators with learning objectives for students. The affective and psychomotor goals are not described in this research due to the emphasis on cognitive skills and their relationship to the problem-solving aspect of the AC Level 1 exam. The test is structured with a variety of definition and scenario problem-solving questions, with an emphasis not on selecting the right answer but the best answer. This approach requires student capabilities of remembering, understanding, applying, analyzing, and evaluating, five of the six cognitive objectives. The application aspect of the AC Level 1 exam tests competency characteristics of the examinee. Analysis and evaluation facilitate critical thinking by the examinee, which differentiates the AC Level 1 exam from typical knowledge-based

examinations. Understanding these attributes of the AC Level 1 exam is important, particularly with regard to test preparation so that preparation exercises include critical thinking.

Lastly, this research would be considered insufficient if the educational concepts of competency-based learning (CBL) were not acknowledged in this study. Voorhees (2001) defines competencies as

> . . . the result of integrative learning experiences in which skills, abilities, and knowledge interact to form learning bundles that have a currency related to the task for which they are assembled. (as cited in Baughman, Bramm, & Mickelson, 2012, p. 115)

Because the AC Level 1 exam is a competency-based exam, where the examinee must complete problems as an estimator, scheduler, safety coordinator, construction project manager, and field supervisor, the preparation materials incorporated elements of CBL so that learning bundles were packaged according to competencies. It is important to understand that the curriculum did not emphasize competencies in a formalized manner as described by Brumm, Mickelson, Steward, and Kaleita (2006):

> Competency-based models enjoy an obvious connection to aspirational student learning statements, because they shift the focus from instructional delivery to student performance (Voorhees, 2001). Competency-based learning (CBL) involves redefining program, classroom, and experiential education objectives as competencies or skills and focusing course-work on competency development. (p. 115)

The coursework, as exhibited in Appendix B, includes knowledge and skill sets that are related to the AC Level 1 criterion and those criterion lead to competencies as defined for estimators, schedulers, safety coordinators, field supervisors, and project managers. Instructors emphasize the skill sets required for each competency and the internship program encourages students to pursue positions they were most interested in after graduation; however, the classroom experience was conducted predominately in a traditional classroom setting. Barnhardt (1994) illuminates an important distinction between curriculum-based vs. competency-based certifications, which also applies to the learning environment by stating that curriculum exams require mastery of a set of instructions as opposed to competency assessment requiring command of application of a body of knowledge.

Another element of CBL models is that they rely on input and judgment from external competent resources in establishing curriculum, which will meet the development needs of students. In this study, the institution of higher education's advisory board performed that role and was highly engaged in curriculum development and providing internship opportunities for students. It is the researcher's assessment that the construction management program in this study contains strong competency-based elements delivered in the modality of a conventional classroom setting, thereby creating a hybrid CBL model.

Lastly, it is significant to note that the program outcomes, as defined on the construction management program website for this study, are listed exactly as the 10 criterion tested in the AC Level 1 exam (Table 2). The alignment between the program

and certification exam allow issues of teaching to the test to creep into the discussion and could impact the replicability of the research in other construction management programs based upon their curricula alignment with the AC Level 1 exam.

Table 2. Alignment of AC Level 1 Exam and Construction Management Program

AC Level 1 Exam Criterion	**Construction Management Program Outcomes**
Communication	Communication skills, i.e., written and oral communication
Engineering Concepts	Engineering concepts, e.g., design concepts and analysis of structural systems
Management Concepts	1. Management concepts, e.g., project financing, economics, and law
Materials, Methods, and Project Modeling	1. Materials, methods, and project modeling and visualization
Bidding and Estimating	Bidding and estimating, including blueprint reading and quantity take-offs
Budgeting and Cost Control	1. Budgeting, costs, and cost control
Planning and Scheduling	1. Planning, scheduling, and schedule control
Safety	Construction safety
Surveying and Geomatics	Construction Geomatics, e.g., site development and layout
Project Administration	Project administration

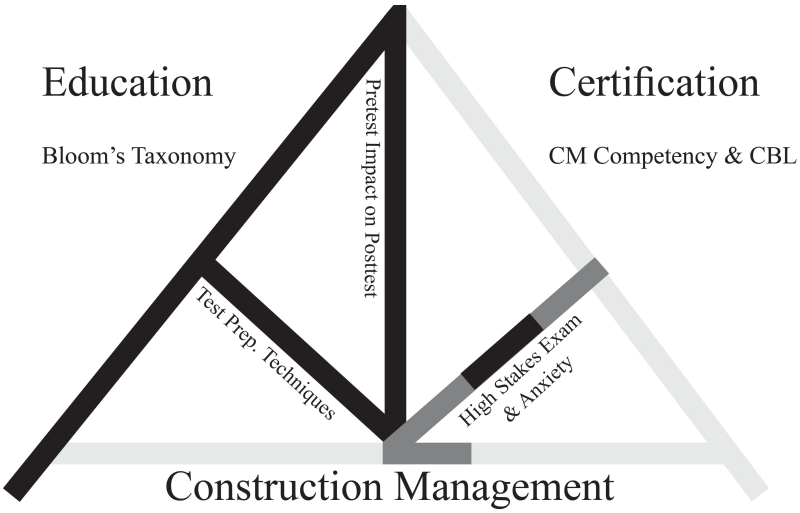

Figure 3. High Stakes Exam—Minimal Literature Related to Construction Management and Certification

High Stakes Exams

A substantial volume of research has been published regarding high stakes exams, particularly college entrance exams such as the Scholastic Aptitude Test (SAT) and American College Test (ACT); however, the extent of construction certification exam research is stark in contrast. The majority of research centers on the aptitude exams' ability to predict collegiate performance and does not focus on preparation techniques. A significant difference between the SAT and ACT, as compared to the AC Level 1 exam, is the former represents an aptitude exam and the latter is a subject criterion-referenced competency-based exam. Aptitude exams test a student's ability to understand, learn, and reason, whereas criterion exams test the mastery of a particular subject. Field and Rowe (2001) have expressed that if the desire of the exam is to evaluate whether a student has attained the goals of instruction, then a criterion examination is more appropriate as compared to an aptitude test. Another dissimilarity between the two types of exams is

that an aptitude exam is norm referenced, in which the examinee's performance is ranked as a percentile ranking within the total group that participated in the exam versus a cut score criterion exam that establishes sufficient knowledge or mastery of the subject matter to allow the examinee to be labeled as achieving competency. The relevance of the differences to this study is to understand that the AC Level 1 exam is criterion based with a cut score of 70% or greater correct answers in order to pass, facilitating the examinee to be a competent entry- level construction professional. Field and Rowe (2001) further state that an assessment instrument, which provides authentic assessment of technological problem solving, is preferable to a norm-referenced aptitude exam, which bodes well for the AC Level 1 exam since it includes numerous problem-solving test items. During AC Level 1 preparation sessions, students are counseled to solve the questions and should the multiple choice answers not seem appropriate, then they should utilize problem-solving techniques to eliminate the worst answers in an attempt to select the best answer. While this technique would probably not provide a sufficient number of answers to produce a passing score, students are encouraged to use problem-solving techniques that serve them well in their future careers.

The literature search also focused on exit exams from collegiate programs and, unfortunately, research studies were not available for the use of high stakes exams in this context. A significant amount of research has been written on the usage of high-stakes exams in the K–12 learning environment, as noted by Atkinson and Geiser (2009):

> . . . in our K-12 schools: standards-based assessments developed by the various states as part of the movement to articulate clearer standards for

> what students are expected to learn, teach to the standards, and assess student achievement against those standards. The schools are well ahead of colleges and universities in this regard. (p. 670)

While educators and policy makers have recently debated the merits of standards-based assessments in the K–12 systems, this research mentions this form of assessment only for the basis of providing contextual comparison to competency-based certification exams. The standards testing utilized in K–12 education are curriculum-based achievement exams that Atkinson and Geiser refer to as measuring mastery of a specific subject and are dissimilar to competency exams since they exclude application of skill sets to perform a job or function.

Atkinson and Geiser (2009) conducted a large-scale study at the University of California that tracked long-term outcomes, and their findings supported research by Geiser and Santelices (2007) that high school grades were better predictors of higher education students' cumulative grade average and 4-year graduation rates when compared against standardized tests. Additionally, their research compared the consistency of SAT I reasoning exams with that of SAT II subject exams and found that the subject exams were better in predicting student success in college. The relevance to this study lies in the strength of subject exams, which bolsters credibility of the AC Level 1 exam since it is aligned as a subject exam and not an aptitude test. Geiser and Santelices (2006) also posited that Advanced Placement (AP) exams conducted in secondary education were second only to high school grades as indicators of success when compared to standardized aptitude exams. The findings of AP effectiveness are

additionally supported by Bowen, Chingos, and McPherson (2009) national study of AP performance relative to public university completion. Atkinson and Geiser (2009) specifically state that when comparing subject vs. aptitude exams,

> It is true that subject-specific tests (in particular the AP exams) do have a statistically significant predictive advantage (Bowen et al., 2009; Geiser & Santelices, 2006), but the statistical difference by itself is too small to be of practical significance or to dictate adoption of one test over another (p. 672).

Suffice it to say, this difference between subject and aptitude tests is relative to this research study since the AC Level 1 demonstrates the hybrid characteristics of subject and competency exams; however, the debate of which test is preferable to general education contains no value for this study.

One characteristic that does pertain to this study is the concept of "teaching to the test" and is common to subject or criterion examinations. The AC Level 1 preparations in this study were presented in specific modules that qualify as teaching to the test with the one distinction being that they were also competency based, which implies that the student must demonstrate application of the knowledge taught. The layer of competency requires the student to go beyond the instructional step-by-step procedures that were taught in the classroom and consider the application of knowledge learned through his or her experiences as an intern practitioner. The depth of learning required in successfully passing competency assessments distinguishes the difference between aptitude and subject-referenced examinations. Another important point to consider is that Field and

Rowe's (2001) assertion of criterion-referenced exams provide a better assessment tool than an aptitude test is also supported by Atkinson and Geiser's (2009) viewpoint when they state, "…criterion referenced tests certify students' knowledge of preparatory subjects and help to establish a baseline for judging applicants" (p. 673).

A less tangible element of high-stakes testing is anxiety. Salend's (2012) research on test anxiety included findings from Cizek and Burg (2006), and Huberty (2009), stating,

> During testing, students experiencing test anxiety encounter extreme levels of stress, nervousness, and apprehension that drastically hinders their ability to perform well and negatively affects their social-emotional and behavioral development and feelings about themselves and school. (p. 20)

Salend (2012) proposes that while educators are responsible for conducting tests, they can alleviate most test anxiety through

- aligning unrealistic student expectations and minimizing perfectionist tendencies;
- minimizing criticism and supporting positive self-esteem;
- providing timely preparation efforts, avoiding procrastination, facilitating personal student motivation and confidence;
- developing student study and test-taking skills;
- minimizing pressure from teachers, peers, and family;
- creating a positive and replicable testing environment;
- providing valid assessments; and

- eliminating ineffective teaching.

Research conducted by Cassady (2010) and Huberty (2009) was included by Salend (2012), which indicated that 25% to 40% of students experience test anxiety. Specific suggestions for minimizing stress are to promote validity of the tests by aligning content to the most important curriculum or skills required, utilization of simulations, cooperative learning, and problem solving strategies in the classroom, weighting the questions to equal proportion of their importance and preparation, and lastly offer assessments on a regular periodic basis to reinforce learning. Motivation can be fostered by relating subject content to students' lives and long-term goals during test preparation exercises so the learning content becomes more relevant to the students experience. Other more tangible measures for stress reduction can involve self-awareness of how each student's body reacts to tension and providing alternative breathing or relaxation techniques to remove the stress during exams. Educators can reduce the sense of being overwhelmed by presenting learning content in smaller bundles to facilitate a feeling of manageability by the student. Lastly, actual test-taking strategies can be emphasized by instructors, which include the following:

- Upon receipt of the exam, perform a memory download by placing notes with key memory clues or points so they can be expounded upon later in the exam.
- Initially survey the exam to answer the easy questions first so additional time is allowed for more difficult questions.

- Be aware of the time allotted to complete the exam and know the average time allowed for each question so the examinee can maximize the number of answers addressed in time sensitive exams.
- Highlight critical instructions or key words from the question to create focus on the intent of the desired answer.

Cassady (2004) further enhanced literature on test anxiety by advancing previous research by Schutz and Davis (2000) and Zeidner (1998), which indicated that there are three phases of anxiety that occur during the learning cycle: test preparation, test performance, and test reflection. Within the test preparation phase, Cassady (2004) quotes Covington's (1992) assessment that those students who demonstrate poor study skills also exhibit issues in self-awareness monitoring. Cassady (2004) further states,

> On the other end of the continuum, those students who perceive their skills to be insufficient for successful performance are more likely to adopt performance-avoidance goals driven by a fragile or low self-efficacy (McGregor & Elliot, 2002), which often manifests through procrastination (Cassady & Johnson, 2002; Wolters 2003).

The combination of low self-efficacy and test anxiety can present an intangible obstacle to the student during the test preparation cycle, which implies the importance of the instructor attuning to students and providing a supportive environment. Test performance phase anxiety is defined as cognitive test anxiety created from anxiety blockage phenomenology. Investigation has illuminated that phenomenon to occur when a student with good study skills experiences interference, distractibility, or inefficient cues caused

by anxiety. Cassady (2004) further illustrates that examinees typically develop impressions of test difficulty in the first few minutes of an exam and per additional research, "infer that the exam is difficult, prompting self-deprecating thoughts, task-irrelevant thinking, or emotional reactions that detract from concentrating on the task itself" (Sarason, 1986; Shutz & Davis, 2000).

The last phase, test reflection, perpetuates self-deprecating performance based upon previous test failures and can hinder the student's ability to respond to instructional challenge and motivation. The characteristic of a self-fulfilling prophecy becomes particularly important for the instructor to ascertain and attempt to reverse by creating a positive learning environment. In summary, understanding the nature of high stakes exams and the potential obstacles beyond knowledge of test content are important for the next phase of this study, test preparation techniques.

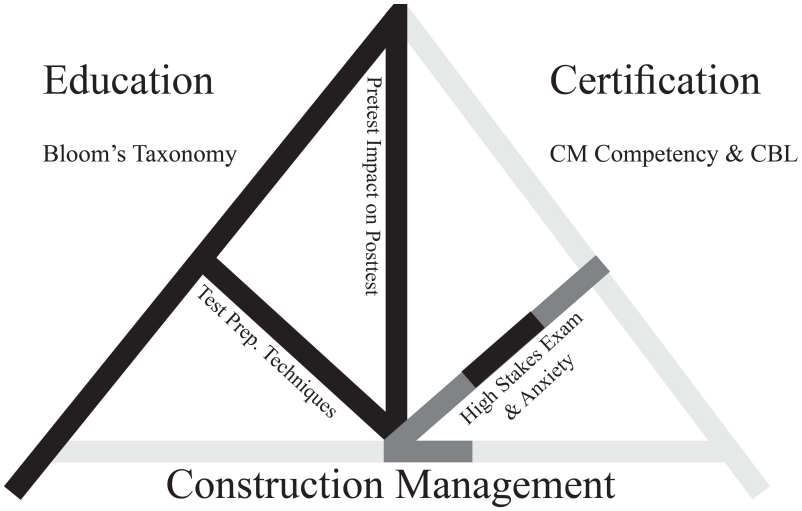

Figure 4. Test Preparation Techniques—Abundant Literature

Test Preparation Techniques

This aspect of the research study has the greatest effect on students with regard to their motivation, confidence development, and overall experience during the exam preparation phase. While these elements are intangible in nature and can vary greatly among the examinees, the final results are tangible and many times of most concern to the educators. Bernold (2005) focused his work on assessing the paradigm shift required in modern day construction education and posits that learning is enhanced when approached as a personal process of inquiry and not as a product of instruction. The critical factor in the personal inquiry approach involves student engagement beyond instructor entertainment. Bernold (2005) goes further to quote *Confucius circa 450 BC*

> "Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand (p.533)."

Involvement is more than asking questions; rather it reaches the desire of the student in the ways they want to learn, and appeals to their sense of long-term purpose. O'Banion (1997) takes this concept farther by emphasizing learning communities, where a cooperative learning environment is fostered, active learning is experienced, collaborative leadership is encouraged, and instructor focus is based upon who is in the classroom. Similarly, Bernold (2005) suggests that working in teams fosters interaction, reflective argumentation, interpersonal trust, and sense of being needed to achieve a higher goal of learning. Suggestions by O'Banion (1997) on how to develop learning communities are as follows:

a. What kinds of learning do we value most?

b. What conditions do we need to create to best support the kinds of learning we value most?
c. What are the primary learning styles of our students, and which of these can we best accommodate?
d. How can we provide more learning experience options for our students to respond to their diverse learning styles?
e. How can we use technology to better help our students extend and expand their learning? (p.535)

The researcher served the role of instructor for test preparations in the capstone course of the construction management curriculum and considered each of these questions in creating the learning environment. Steps taken by the researcher to create a learning community are as follows:

- Involvement fostered through input from the examinees prior and during exam preparation organized activities.
- Flexibility of organized activities based upon student feedback; specifically, flipped approaches where exams, study materials, and sample problems were administered outside of class time and team problem-solving activities were facilitated with all students in class.
- Students were encouraged to establish teams (small groups) outside of scheduled class hours to facilitate differing approaches to learning the material and working together to solve out of class problems.

- Since a majority of students worked during the day as construction interns, technology was offered as a means of communicating through exposure to free collaborative software, specifically Wiggio. Other students, who were already connected through Facebook, chose to utilize this platform as a means of coordinating external class meetings and questions regarding problems presented each week. The universities web based platform, BlackBoard, was utilized to facilitate asynchronous dialogue between students and the capstone course instructor through creation of a discussion board. The purpose of the discussion board was to present questions by the students that emerged from review of the study materials and organized preparation sessions. All students had access to the discussion board in BlackBoard versus the voluntary digital platforms, Wiggio and Facebook.
- Students were also encouraged to work with classmates who complemented their weaknesses in the 10 AC Level 1 constructs. Further emphasis was conveyed by the instructor each class period for the students to focus on their weaknesses in order to develop confidence in their ability to perform well on the AC Level 1 exam. Confidence became a secondary byproduct of this focal point, with self-awareness being the primary and most enduring benefit.
- Diverse learning styles were addressed through the variety of instruments to convey and assess knowledge.
    - Weekly quizzes were offered for a period of 7 weeks with grade requirement of only five exams, thereby making two of them voluntary, so

student flexibility was facilitated to focus on their areas of weakness. Students often requested to take these quizzes twice to reinforce their learning, and the instructor made this available after a week gap between the first quiz. It is important to note that these quizzes were composed of 12–15 questions/problems and were implemented through BlackBoard during a 12-hour access period. Most quizzes required 30-45 minutes to complete, depending upon the nature of the learning content, i.e., if a lot of problems were involved in the assessment, the quiz ran longer.

- Large group review sessions (two in the spring of 2012 and five in the fall of 2012) were facilitated by instructors and were voluntary for students. This mode of knowledge dissemination aided those students who needed additional instruction to master subject content.
- Videography was also utilized to provide flipped classroom opportunities to those students whose schedules were not as flexible or who preferred to learn without distraction of the typical classroom and allow repetition of personally difficult topics. Subject-specific videos were also made available through YouTube by the researcher on those topics considered the most difficult or a higher percentage of content covered in the AC Level 1 exam, i.e., scheduling, construction financing, and conceptual estimating.
- Dropbox, a web-based file-sharing system, was utilized by the researcher to share problems for the students to work outside of class periods that

enabled faster delivery as students expressed via e-mail their issues with different subject content.

- Class time was divided equally into lectures for the next week's external class exercises, question and answer (Q&A) from material studied during the week, and team problem solving. Students were encouraged during Q&A to share their experiences that aided their understanding of the material or relate it to their actual internships. Relating the material to their work experiences provided the element of long-term beneficial purpose for the student.
- Web-based third-party study and assessment were offered to all students from Red Vector for those students who preferred additional testing and the use of digital study references.

The researcher observed an increased level of engagement by the students during these two semesters and a reduction of anxiety as compared to prior semesters, which were not included in this study, and preparation measures were not as many or as organized. While the researcher acknowledges that the Hawthorne effect may be an issue regarding perception of student engagement, these preparation measures are not the primary focus of the research study. The illumination of these measures provides context and additional literature for the interested educational practitioner. The actual experience of the mock exam students will be discussed in the findings; pre-mock exam and post AC Level 1 exam surveys were conducted by the experimental participants.

Bernold builds upon his knowledge by referencing Kolb & Fry (1975) where they posit that effective learning is created by providing concrete experience, reflective observation, abstract conceptualization, and active experimentation. Bernold (2005), conducted a learning and study strategies inventory (LASSI) of 1,000 freshmen students in construction management from a major public university and found that six of the 10 categories were higher than 50%, attitude and interest in academic success, motivation to exert necessary effort to succeed, time management skills and effectiveness, ability to focus on academic tasks, knowledge of study methods (metacognition), and proficiency in self-evaluation monitoring. The remaining four categories of LASSI fell between 34% and 49%, anxiety about school and academic performance, information processing skills, ability to identify main ideas, and test-taking strategies. While a LASSI assessment was not utilized in this research, the findings of the study performed by Bernhold appear relevant, as concerns of collegiate students with regard to study skills were a consideration in utilizing the mock exam as a preparation method. As an example, student motivation was a concern for the researcher when developing the curriculum of study preparation for the AC Level 1 exam, which resulted in the idea of the mock exam in the beginning of each semester in an attempt to kick-start student motivation and create consistent time management until the date of the actual exam. Proficiency of self-evaluation was a specific target of the researcher to develop by each student. While the actual mock exam results were not distributed to each participant, the students did raise their level of awareness in their knowledge proficiency by participating in the mock exam. Furthermore, subsequent preparation sessions continually reinforced mock exam

students to draw upon the areas of weakness demonstrated by the mock exam results and emphasized their study focus on the same areas. Other interesting findings from Bernold's (2005) study indicated that

- 68% of students found it too difficult to learn during class due to intensive note taking,
- 54% of students were intimidated with test taking even when they felt prepared, and
- 95% of students believed that the best preparation for exams was to perform homework problems similar to test examples during class time (p. 537).

When preparing curriculum for the students included in this study, the researcher considered the significance of each of these findings. The outcome resulted in the following differences in pre-research study preparation methods:

- Lecture materials were distributed to all students prior to the presentation date in class to eliminate timely note taking and enable more time to focus on the materials and interaction during problem-solving exercises.
- Lecture content was presented in seven modules, distilling the content down to a more manageable size when compared to the AC Level 1 Study Guide provided by the AIC (800 + pages).
- Weekly quizzes, of approximately 12–15, questions, were administered via Blackboard for 7 weeks as a means of assessing mastery of content.

- Sample problems were distributed weekly prior to class that were worked on during class in groups to increase student confidence and facilitate active learning.
- A final session was presented on test-taking techniques to bolster confidence and reduce student's feeling of intimidation.

It should be noted that these activities were made available to all participants of the study with the only difference between the two semesters being that the second semester students experienced three more sessions of organized class exercise focused on the AC Level 1 exam content.

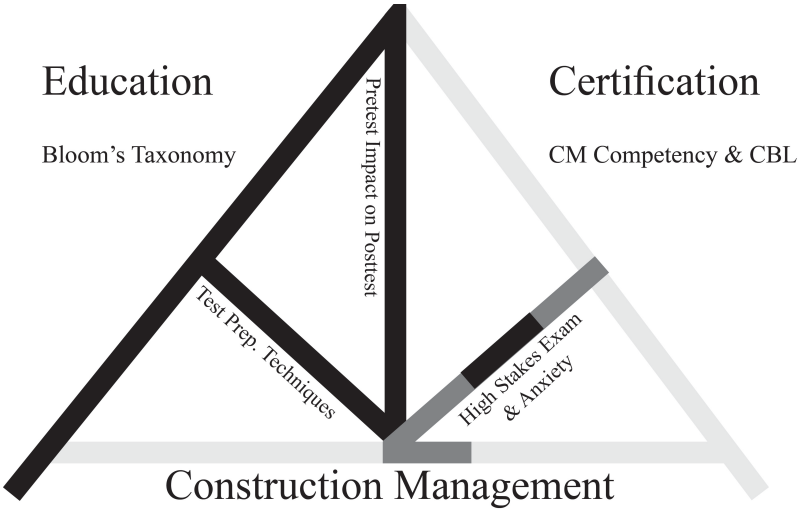

Figure 5. Pretest and Posttest—Abundant Literature

Pretest Impact on Posttest Results

The methodology of this study is predicated on a pretest to posttest design within groups over time, where the time within the groups represents an experimental group participating in the mock exam (pretest) prior to the treatment (test preparation) at the

semester's commencement, and the posttest (AC Level 1 exam) is administered at the end of the semester. The AC Level 1 certification exam results are compared between the experimental and control group (non-mock exam participants) to assess if there is a statistical significance in passing performance on the AC Level 1 exam between the two groups. In order to eliminate anomalies in the data and identify any patterns, the study was conducted during two continuous semesters (spring and fall of 2012). Further details of this study's methodology will be illustrated in the next chapter; however, this understanding is significant when considering the literature reviewed to place this research characteristic in context. Characterization of pretest-posttest data is that two measurements are conducted on one experimental unit, typically with a treatment administered between the assessments, allowing temporal distance. This type of research can indicate either the impact of the treatment or, as in this case, the impact of the pretest since the control group did not participate in the initial assessment (pretest). The existence of the control group is key to discerning impacts of the differing treatment (mock exam) since all other elements of the experiment are similar. Should a control group be excluded from the experiment, and then difficulty would arise in determining if the change in performance was due to unreliability of the measuring instrument or actual change in the study participant. Ideally, this type of research would consist of matched pairs in both the control and experimental group; however, due to the voluntary nature of participating in the mock exam, this aspect of the research was unattainable. Bonate (2000) states.

> A more persuasive argument is that supposing a study is done and it is found after the fact that baseline comparability among groups did not exist. Does that mean that the results of the study are invalid? Certainly not; it simply means that greater care must be exercised in the interpretation of the result. (p. 5)

Bonate (2000) further supports his viewpoint by including Enas, Enas, Spradlin, Wilson, and Wiltse (1990) and Senn's (1994) argument that baseline homogeneity is moot due to the realization that treatment groups cannot be represented as identical. These viewpoints imply that unbalanced comparison groups do not devalue statistical analysis; rather, they affect the ability to infer conclusions. The commonalities between the control and experimental groups are all have reached the same level of attainment in their studies based upon prerequisite requirements of the program, and all qualify to participate in the exam per the CCC requirements. Specific bias, which may result from this condition, will be further addressed in the chapter on methodology.

Pretest sensitization, where the pretest increases sensitivity of the study participants to the treatment of an experiment, can occur in a subject's attitudes and learning between the time period of pre- and posttest. Lana (1969) states,

> . . . any manipulation of the subject or his environment by the experimenter prior to the advent of the experimental treatment, which is to be followed by some measure of performance, allows for the possibility that the result is due either to the effect of the treatment or to the interaction of the treatment with the prior manipulation. (p. 44)

In this particular study, where both the control and experimental group experience the same organized preparation methods and the differential is defined as the pretest (mock exam), it is reasonable to assume that pretest sensitization would impact the posttest results and would not be considered negatively since they were the byproduct of learning from the experimental group's participation with the pretest. Pretest sensitization, or more commonly referred to as response shift by Howard, Ralph, Gulanick, Maxwell, Nance, and Gerber (1979), may occur as bias when self-reported attitudes toward the learning content are utilized as outcome criteria. This condition reveals itself when pretest and posttest self-reports are utilized to reflect participant behaviors or attitudes, and while this study employed the use of an opinion survey after the experimental group completed the mock and AC Level 1 exams, these surveys are added to this study as a qualitative description of the mock examinees' learning experience and are not statistically analyzed.

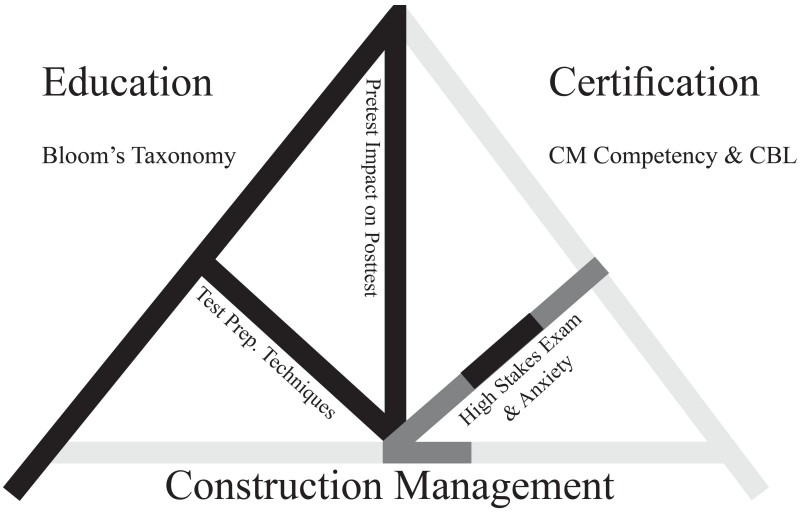

Figure 6. Research Study Literature Review Model

Literature Review Summary

While there is not an abundance of existing research on construction management education and certification, there is evidence of significant research regarding the other fundamentals to this study, high-stakes exams, test preparation, and pretest and posttest research. The intent of this review was to demonstrate current baseline understandings relative to each foundational topic and their relationship to the aspects of this study. To summarize the pertinent concepts discovered from the literature:

- Construction education and certifications are relatively new to the profession and assist in unifying project management professional standards.
- Construction professional demand is rising in the US and is projected to grow by the largest percentage of any industry, at 4.1%, through 2022,
- Competency-based learning is an important component in construction education.
- The AC Level 1 exam classifies as a criterion test versus the aptitude tests (SAT and ACT).
- The AC Level 1 exam classifies as a high-stakes exam similar to other national exams (SAT and ACT).
- Examinee anxiety management and test preparation are important elements for successful completion of high-stakes exams.
- Pretest and posttest statistical analysis form the best framework to measure the impact of the mock exam on student success with the AC Level 1 exam.

Now that the context of foundational aspects of this study has been illuminated relative to existing literature and the possibilities of adding to construction management education

and certification are recognized, the following chapter will address the specific methodology of the experimental research.

Chapter III

Methodology

Purpose and Justification

The purpose of this study was to determine if a preponderance of evidence existed to support the claim that a mock exam, as a preparation technique, would enhance pass rates on the actual AC Level 1 certification exam for senior-level students in higher education construction programs. The study's design compared student performance on the AC Level 1 certification exam between examinees that participated in the mock exam and utilized quantitative methods. Additional qualitative self-report feedback was included in the form of student surveys from those who participated in the mock exam to assess perception and attitudinal responses to the intervention. All data spans the two semesters included in the research study and analysis was conducted after completing both the mock and AC Level 1 exams.

Justification for this research was to aid students in preparation for the AC Level 1 certification exam. The previous three semesters of AC Level 1 test results from students attending the construction management program of the study demonstrated a poor passing rate of just over 50%, which was lower than the national average of other students from similar construction programs. A plethora of research has been conducted on high-stakes testing with more specific reference to test anxiety. While there has been a moderate degree of research conducted on the attributes required for entry-level construction management success, there is a gap in the combined fields of construction education on preparation best practices for high-stakes certification exams. This research

will provide knowledge for both national and international construction management programs, especially in a time where construction certification exams are on the rise.

Research Question

The primary question addressed by this study

- What are the differences between the scores for the construction management students who take both the mock exam and the AC Level 1 certification exam?

The secondary question addressed by this study

- What are students' perceptions of the mock exam as a preparation assessment instrument at two specific time frames during the preparation phase, specifically, after completing the mock exam and the AC Level 1 certification exam?

Research Setting and Background

The research was conducted at a public university in the southern United States. The researcher served dually as both instructor in the construction management program and researcher. Bachelor degrees from the program are awarded upon successful completion of 120 credit hours, which includes construction, engineering, and business management. Comparison of demographic parameters for the construction management program vs. university enrollment is presented in Table 3.

Table 3. Fall 2012 Enrollment Characteristics

Enrollment by Section	Student Count	White %	Hispanic %	Asian %	African American %	International %	Unknown %
Construction Management Program	310	50	36	8	6	0	0
University	40,707	32	25	19	12	9	3

The AC Level 1 exam is utilized as a high-stakes exam in which passing the exam is mandated in order to pass the capstone course and graduation with a degree in construction science. Passing the exam and earning certification requires a minimum cut score of 70% or correctly answering 210 questions from a total of 300. Approximately 67 universities participate in offering the AC Level 1 exam; however, no other institution, with exception of the university studied, requires the exam as a prerequisite requirement for graduation. The primary purpose of the AC Level 1 exam is to provide an entry-level construction certification and is administered by the Construction Certification Commission (CCC). This commission is an independent third-party agency affiliated with the American Institute of Constructors (AIC) and has received accreditation from the American College of Construction Education (ACCE). The American National Standards Institute (ANSI) has also accredited the AC Level 1 exam.

Ethics

IRB approval was granted through the university's research governor and was based upon retrospective historical data retrieved from students' test scores for both the mock and AC Level 1 exams. Further consent was also granted by students who took the AC

Level 1 certification exam through agreements to release their scores to the university and the professor of the construction management program in the study.

Since this study deals with aspects of high-stakes testing, the researcher acknowledged the recommendation of the American Educational Research Association (AERA) with regard to high-stakes exams, enumerated below:

- High-stakes exams should be fair to all students.
- Other assessment sources besides the high-stakes exam should be utilized for overall evaluation. (While this study excludes the merits of overall evaluation, it is important to know that higher authorities in the institution are responsible for the decision to base graduation from the program and passing the capstone course on this single exam.)
- High-stakes testing should be based on the curriculum taught in previous classes.
- Validity and reliability should be repeatedly tested over time to ensure the exam is working as intended.

Cost Analysis

The primary expense for this research was based on the hours to prepare and proctor the mock exam, which was approximately 200 hours at the rate of an associate professor salary, equating to an investment of $12,000. Upon completion of the mock exam and the successful protection to keep the content from future students, the ongoing cost to implement this preparation practice in other institutions would be minimal for proctoring the exam. Assuming, of course, that all major higher education institutions provide BlackBoard at no additional cost to the construction management programs, this

investment appears to be minimal as compared to the benefit gained by the increase in student test performance.

Research Design

The study is classified as quasi-experimental since participation by subjects was voluntary, not random. The experiment is quantitative in nature and included pretesting and posttesting over two semesters. Data included parametric statistics on interval test scores, which were paired between students who completed both the mock and AC Level 1 exam.

Hypothesis and Null Hypothesis

Hypothesis: Students who take the mock exam experience a statistically significant improvement in passing scores on the AC Level 1 certification exam as an experimental pre to post exam group.

Null Hypothesis: There is no significant improvement on passing scores from the mock exam to AC Level 1 certification exam by students who take both exams.

Instrument Development, Validity, and Reliability

There were two instruments required for this research experiment. The first was the pretest, or mock exam, and the researcher developed this instrument. While BlackBoard addressed the questions as true/false and multiple-choice answer selection among several options, it should be noted that the answers to most questions required calculations or problem solving similar to the AC Level 1 exam. Additionally, the researcher intentionally modified the percentage of each construct's content in the mock

exam to reflect the weakest areas demonstrated by previous students (refer to Table 4). The researcher utilized the prior AC Level 1 results for each construct and subjective judgment to balance the needs for student preparation and the intent of the AC Level 1 exam.

Table 4. Construct Percentages in Mock vs. AC Level 1 Exams

Construct #	Construct Scope	% AC Level 1 Exam	% Mock Exam	% Delta (Mock to AC Level 1)
1	Communication Skills	5.5%	4.3%	–1.2%
2	Engineering Concepts	9.0%	18.0%	9.0%
3	Management Concepts	4.0%	13.0%	9.0%
4	Materials Methods Plan Reading	10.0%	6.3%	–3.7%
5	Bidding and Estimating	17.0%	7.3%	–9.7%
6	Budgeting, Costs, and Cost Control	10.5%	9.7%	–0.8%
7	Planning, Scheduling, and Control	16.5%	22.3%	5.8%
8	Construction Safety	7.0%	5.7%	–1.3%
9	Surveying	2.0%	2.3%	0.3%
10	Project Administration	18.5%	11.0%	–7.5%

The second instrument of measure was the AC Level 1 exam, and the researcher had no knowledge of the actual questions or instrument development other than the 10 criteria included in the exam. It is important to understand that the researcher had access to the study questions in the AIC preparation guide so the general content was known when designing questions for the mock exam. Validity of the instrument by the CCC as an outside expert was particularly important since the researcher did not have access to actual AC Level 1 exam questions, which are referred to below.

Three types of validity are relevant for a study of this nature: face, content, and criterion. Face validity is determined by a review of the mock exam instrument by experts—members of the CCC testing committee—to determine if the mock exam emulates the actual AC Level 1 exam. Content validity is evaluated by comparing the content from both the pretest and posttest. Since the researcher did not have access to the AC Level 1 exam, the enumeration of criteria and test questions were submitted to the AIC Executive Director for the purpose of soliciting an independent review by the CCC testing committee. In order to preserve the integrity of the face validity evaluation, the researcher limited contact to only the Executive Director. The AIC Executive Director facilitated the review by the CCC testing committee and relayed the overall finding to the researcher. The committee was able to make the final determination of content validity between the two instruments. Criterion validity refers to whether the mock exam highly correlated to an exam that is recognized as the measure of its construct. This was evaluated after both semesters of mock exam results were determined.

Potential threats to validity have been evaluated based upon the research design and are listed as follows:

- Subject Characteristics: Age, grade point average (GPA), and construction experience are factors that can influence performance on either exam. As noted above, age varied from student to student, but the vast majority of students were in the range of 21–29. GPA was not included in the scope of this study. Lastly, actual construction experience varied between participants since some students worked full time during their educational pursuits. It is important to note that all of these characteristics were measured and evaluated through SPSS, with the exception of construction experience.
- Subject Attitude: The Hawthorne Effect could have an influence on test scores because the experimental group may put more effort into the process, resulting in better exam performance due to their feelings of importance as part of the experiment. This may be especially true since the researcher and teacher is the same person.

In a pretest and posttest design, reliability is created through consistent scoring on the instruments over time. Typically, the time period required to determine reliability is 2–3 months. Since the exams were administered within a 14-week period, the timing component met the requirement for reliability. The actual scores from the mock exam were examined for their consistency to determine reliability.

Sampling

The sample consisted of students who were enrolled in the capstone course from the construction management program and who were taking the AC Level 1 exam for the first time. The class size per semester averaged 40 students and included two semesters. These were senior-level students and the demographics comparison is included in Table 3. As previously addressed, the students who took the mock exam did so on a voluntary basis since the mock exam required an 8-hour commitment on a Saturday.

Data Collection

Mock exam scores were gathered from BlackBoard, since the exam was administered through the secure electronic platform. The researcher served in a dual capacity as the proctor for the exam and prohibited students from downloading the exam to protect privacy and integrity of the exam for future application. AC Level 1 exam scores were collected directly from the AIC based upon permission granted from students through the exam application process. Deliveries of the test scores were transmitted electronically with password protection to protect the privacy of student results. The researcher utilized an independent identifier code between the two sets of data in order to maintain the privacy of the study participants. Additional characteristic data, ethnicity and age, were gathered through enrollment reports for each student, and student privacy was protected through the student-teacher relationship. All quantitative data was uploaded into SPSS for statistical analysis, password protected, and stored on campus with the researcher's dissertation chairperson and advisor. Qualitative data was collected

through an online secure platform, Survey Monkey, with final results scanned in password-protected electronic files and stored with the quantitative data.

Exam Procedures

Procedures for the administration of both exams were identical with exception of the test instrumentation method. The mock exam (treatment and independent variable) was administered through an electronic medium, and the AC Level 1 exam (dependent variable) was delivered in paper test booklets with Scantron as the means of recording the scores. Both exams were proctored by faculty members, and test sites are identical in building location, duration of time allowed for the exam, lunch break, and date. The mock exam was offered on the Saturday following the first week of each semester and the AC Level 1 exam occurred on the Saturday of approximately the 14th week of each semester. Students were allowed to bring a calculator and pencil to the exam, and scratch paper was provided and collected after the exam to prevent details of either exam from becoming public. The timing of the mock exam mimicked the AC Level 1 exam by allowing 4 hours to perform the morning portion of the test, an hour lunch break, and 4 hours in the afternoon to complete the exam.

Independent and Dependent Variables

The scope of this quasi-experimental study included an independent and dependent variable for the purpose of analyzing the effectiveness of the mock exam on passing rates for the AC Level 1 exam. The independent variable, or experimental treatment, was the mock exam score from the experimental group of voluntary students,

which spanned two semesters of data. Each student included in the data analysis was based upon the parameter that it was their first attempt at taking both the mock and AC level exam. The dependent variable, or outcome, was the AC Level 1 exam score achieved by all students in the treatment and control groups, spanning the same two-semester time period.

Potential Confounding Variables

Based upon the characteristics of the university program, students who participated, and timing of the experiment, the following confounding variables may have influenced the study results.

Subject Characteristic—GPA. This may be a confounding variable however; data was not included in this study.

Subject Characteristic—Anxiety. Since this was a high-stakes exam, anxiety was considered a confounding variable. The presumption was that familiarity with the mock exam may reduce anxiety for the AC Level 1 exam (posttest). This study did not include assessment of participants' anxiety levels.

Subject Characteristic—Age. The majority of students were generally in the range of 21–29 years old; however, there were a few students who were in their 40s or 50s. Maturity and desire to accomplish certification may be stronger in students who are older. As a faculty member, the researcher had access to this data and performed statistical tests to assess whether a relationship existed between the age and the dependent variable.

Subject Characteristic—Construction Experience. Since the exams included content that is predicated on both academic knowledge and industry application, variances in student construction experience could influence test performance. All students are required to complete a 400-hour internship prior to the capstone course; however, some students worked during the day in construction jobs so they may have had more experience, thereby influencing their ability to pass the AC Level 1 exam. This study did not include this variable in the analysis since the 400-hour requirement applies to all participants.

Subject Characteristic—Student Motivation. This characteristic was not assessed because it could have influenced those who chose to volunteer for the mock exam versus those who did not. The additional effort required to participate in the mock exam could be an indicator of motivation to succeed.

Subject Characteristic—Student Awareness. Participants of both exams, who suffered from distortion of their actual knowledge abilities on the content included in the test, may have created a false sense of confidence. This false sense of confidence could have affected study preparation efforts by the student, which may in turn have impacted the AC Level 1 test score. This characteristic was not measured for each study participant in this study.

Student Organized Test Preparation Techniques. Unknown outside study groups may have existed for all subjects who participated in the study. There was no attempt made to discern if the control or experimental subjects utilized additional preparation techniques to aid them in studying for the AC Level 1 exam.

Educational Consistency. Teaching in previous classes may vary due to the high count of adjunct faculty in the educational program of this study. The program generally utilizes 19 adjunct faculty members as compared to four full-time professors. Since the ratio was weighted heavily toward adjunct faculty, based on the low pay scale of adjunct faculty members, turnover may have been high and thus teaching experience low. This inconsistency in preparation and knowledge dissemination could have had an impact on consistent knowledge transmission to the study participants. Collection of this type of data would have required a more extensive design than was planned for in this study and was not accounted for in the results.

Test Administration. Differing administration of the mock and AC Level 1 exam could have created some confounding effect. Scantron was utilized as the mode for administering the AC Level 1 exam (posttest), whereas BlackBoard was the mode for administering the mock exam (pretest). Therefore, one exam was completed with paper and pencil and the other via electronic Web application. It is possible that some students were more comfortable with the electronic mode of test dissemination and the Scantron could be a slower method, which could have impacted scores negatively. As this appeared to be a minor element, the researcher did not develop an assessment tool to collect student perception on this issue.

Test Construct Percentage Focus. The mock exam's 10 criteria varied from the AC Level exam in the percentages of each. For example, the scheduling criteria may be worth 15% of the overall score on the AC Level 1 exam but the number of questions was increased to create 18% coverage for scheduling on the mock exam. This was done to

emphasize the areas of weakness for the overall student sample from the previous semester. As the mock exam was being utilized to increase familiarity with the test format, thereby possibly lowering anxiety and building student confidence, the researcher chose to bring awareness to students of their weakest criterion areas. Refer to Table 4 for discrepancies between the AC Level 1 and mock exam construct differences.

Test Question Difficulty. Questions on the AC Level 1 exam vary each semester, so the difficulty factor can be different between subjects. It should also be noted that no two tests are identical on the AC Level 1 exam, which minimizes the potential for cheating. As previously stated, the researcher did not have access to the AC Level 1 exam content, so the ability to measure this variable was not possible for this study.

Instructor Organized Test Preparation Techniques. The researcher performed in the role of capstone course instructor and subsequently attempted to improve preparation techniques from the first to second semester. Improvement entailed more review sessions and the addition of weekly quizzes to provide all students with additional opportunities for test preparation. Since the quantity and type of activities vary between semesters, there was the potential for this to become a confounding variable.

Semester one included two instructor-guided review sessions that were available to all students. Participation was mandatory in one session and voluntary in the other, since they were conducted in class and after hours, respectively.

Semester two included five instructor-guided review sessions that were available to all students. Participation was mandatory in four and voluntary in one, since they were conducted in class and after hours, respectively.

Additional preparation measures employed the use of seven weekly quizzes, conducted via BlackBoard, during a 5-hour window at the same period each week. The quizzes required approximately 30 minutes to complete and allowed students flexibility to take the exam at their convenience. To protect the integrity of the assessment method, students were allowed to take the quiz only once during the 5-hour period and security protection prevented the content of the quiz from being released. Students could view their grade but could not view the actual questions after completion of the quiz. After all students completed the quiz for the week, the instructor allowed students to retake the quiz in subsequent weeks based upon voluntary request. Furthermore, it is important to note that the quiz grades were a small percentage of the student's grade and only the best scores were counted in the event of multiple attempts. The researcher/instructor's intent was to facilitate short and repetitive assessments in the effort to maintain student focus on AC Level 1 exam content.

Those students who received more preparation activities could benefit in passing rates from those who did not experience the additional sessions; however, this study did not compare the differences in scores from semester one to semester two. This aspect of a potential confounding variable could be studied in further detail upon completion of this research.

Constant Variables

Consistent conditions between experimental and control groups are also important to enumerate for the purpose of providing a complete perspective for this study. Each of these common variables is itemized below.

- Same instructor for both semesters of the capstone course.
- Both exams were 300 questions worth 1 point each for a total of 300 points.
- Both exams were pass/fail with 70% or greater qualifying as passing.
- Both exams covered the same 10 learning criteria.
- Both exams allowed 8 total hours for completion.
- Both exams were offered in the same location on campus.
- Both exams were offered during the same week of each semester; mock exam during week one and AC Level exam during week 14, and all organized study programs were offered to students after the mock exam.
- All participants took the AC Level 1 exam for their first attempt.
- All treatment group subjects took the mock exam for their first attempt.
- All subjects were enrolled in the senior-level capstone course at the time of taking both exams.
- The treatment group of students took the mock exam prior to any organized study preparation activities.
- The mock exam questions were the same each semester, so consistency was maintained with all of the experimental subjects. It should be noted that security of the mock exam was important with this condition, so students were not allowed to review the results of their mock exam.

Quantitative Data Analysis

SPSS was utilized to analyze the data with the primary methodology consisting of a dependent two-tailed paired t-test. Since paired statistics was tested, homogeneity of variance existed and was not required in the statistical model.

Replicability

While this experiment could be applied to the other 67 institutions that utilize the AC Level 1 exam, it is difficult to infer replicability due to the high-stakes nature of the exam at the particular university where the study was conducted. Other institutions do not utilize the AC Level 1 exam as a high-stakes exit exam; therefore, replicability is uncertain. Practical significance could be a possible outcome for the other construction management programs, as this research may illuminate the effectiveness of the mock exam as a preparation technique for their students. The researcher's desire and intent is to aid all construction management students in their preparations to perform as professionals, thereby strengthening the industry. Perhaps the results of this study will provide guidance to academicians, students, and construction industry leaders for the purpose of facilitating additional educational methods in preparing for certification examinations

Chapter IV

Findings

Quantitative Findings

SPSS was utilized to analyze the data with the primary methodology consisting of a dependent two-tailed, paired T-test. Since paired statistics inherently demonstrate homogeneity of variance, reporting on this attribute is not illuminated as a statistic in the study. A secondary analysis was performed to determine the strength of the correlation between the mock and AC Level 1 exams. On average, students who participated in the mock exam (M = 174.79, SE = 3.949) experienced a higher mean test score on the AC Level 1 exam (M = 217.79, SE = 3.949), which exceeded the pass requirements of a score of 210, $t(37) = -14.938$, $p < .05$, $r = .681$. The findings of the statistical analysis appear to substantiate the hypothesis that a mock exam, as a preparation technique, enhances pass rates on the actual AC Level 1 certification exam for senior-level students.

Parametric Statistical Outcome Explained

The results of the study are significant with $p = .000$, (Table 5), where there is almost a zero probability that the null is true, thereby rejecting the null hypothesis.

Table 5. Dependent Two-tailed, Paired T-Test Results—Significance

		df	Sig. (Two-tailed)
Pair 1	Mock Score – AC Score	37	.000

The number of students who participated in both the mock and AC Level 1 exams during the two semesters of the study was 38, (N=38), (Table 6), and the total number taking the AC Level 1 exam over the same period was 59 students. The parameters for the study participants were that they had to be taking the AC Level 1 exam for the first time, while being enrolled in the senior-level capstone course. Based upon the parameter for participation, 35% of the students chose not to take the mock exam, leaving a 65% rate for those students who participated in both the mock and AC Level 1 exam.

Table 6. Dependent Two-tailed, Paired T-Test Results—Mean

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Mock Score	174.43	38	18.232	2.958
	AC Score	217.79	38	24.346	3.949

The mock exam subjects demonstrated a mean delta between AC Level 1 and mock exam scores of –43.3 (Table 7), indicating a significant improvement between the two tests. A large value in the mean difference bodes well that the null may be rejected, which further supports the significance test of $p = .000$ (Table 5). Passing scores for both exams fall within the range of $\geq$ 210–300, with the mean experimental group score at 217. The confidence interval represents the boundary range for the true mean, in this case between –49 and –37, and is important with regard to statistical analysis since this rules out the mean equaling zero. Since a zero delta is likely to be ruled out, confidence is generated that the samples represent experimental manipulation and exclude random possibilities.

Table 7. Dependent Two-tailed, Paired T-Test Results—Paired Differences

	Paired Differences					
				95% Confidence Interval of the Difference		
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t
Pair 1 Mock Score AC Score	–43.363	17.895	2.903	–49.245	–37.481	–14.938

Effect size was then calculated to determine the practical implications of the mock exam. This quantification is known by conversion of a *t* value into an *r* value, where *R* = sq. root of [t^2 divided by (t^2 + df)]. The *t* value from Table 7 is –14.938, which when inserted into the equation above produces an *R* = .926. Conventional statistical analysis indicates that a value of *R* between .5 and .8 is considered a large effect size, therefore this study with an *R* = .926 represents a substantive finding. Variance explained for this study describes the degree that the mock exam may be responsible for AC Level 1 passing scores and is calculated by squaring *R.* This study yields a variance explained of R^2 = .857, which indicates that 86% of passing scores for the AC Level 1 exam is based upon participation in the mock exam. This predictive component is rather large and additionally supports the positive impact of the mock exam as a high-stakes testing preparation method.

The Pearson correlation represents a standardized measurement of the relationship between variables where the covariance coefficient must lie between –1 and +1. For this study, the Pearson correlation value is *r* = .681 (Table 8), which indicates a positive relationship between the mock score and AC Level 1 scores (Refer to Figure 7 for

graphic illustration). Review of Figure 7 also reveals the relative linear relationship between the two variables. Since the *r* value is greater than .5, this correlation produces a large effect. The large effect size creates confidence that a genuine relationship between the mock exam and the AC Level 1 exam scores exist.

Table 8. Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Mock Score and AC Score	38	.681	.000

Note. Pearson Correlation: $r = .681$ large and significant (two-tailed) with $p < .05$.

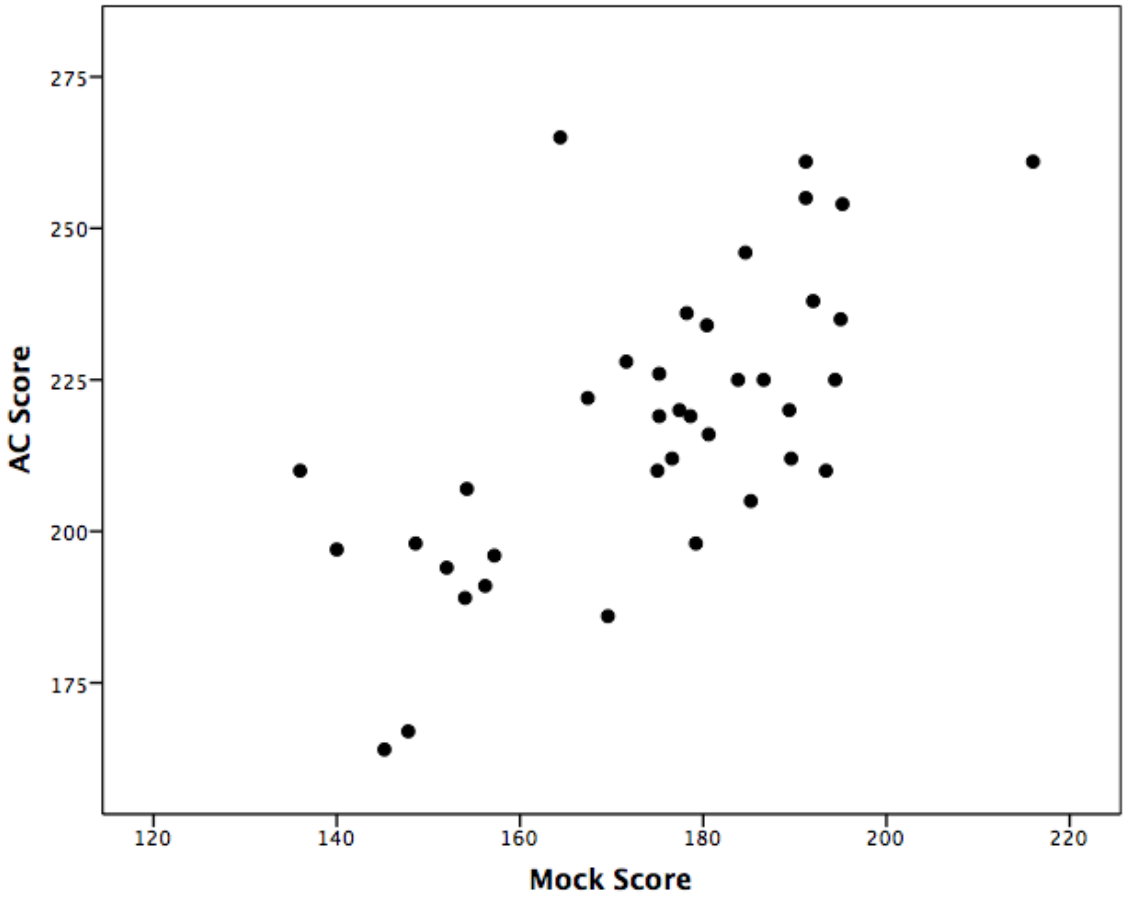

Figure 7. Scatterplot Correlation of Mock and AC Level 1 Exam Scores

Figure 8 is a scatterplot with the *x*- and *y*- axes reversed from Figure 7 and the dotted lines represent the passing score for both exams at 210 points. Initial observation reveals that only one test score passed the mock and AC Level 1 exam (upper right quadrant) and represents an outlier to the study. The lower right quadrant charts all AC Level 1 passing scores from those students who took the mock exam. Visual comparison of the lower quadrants provide prompt recognition that there were predominantly more mock students who passed the AC Level 1 exam from those who did not.

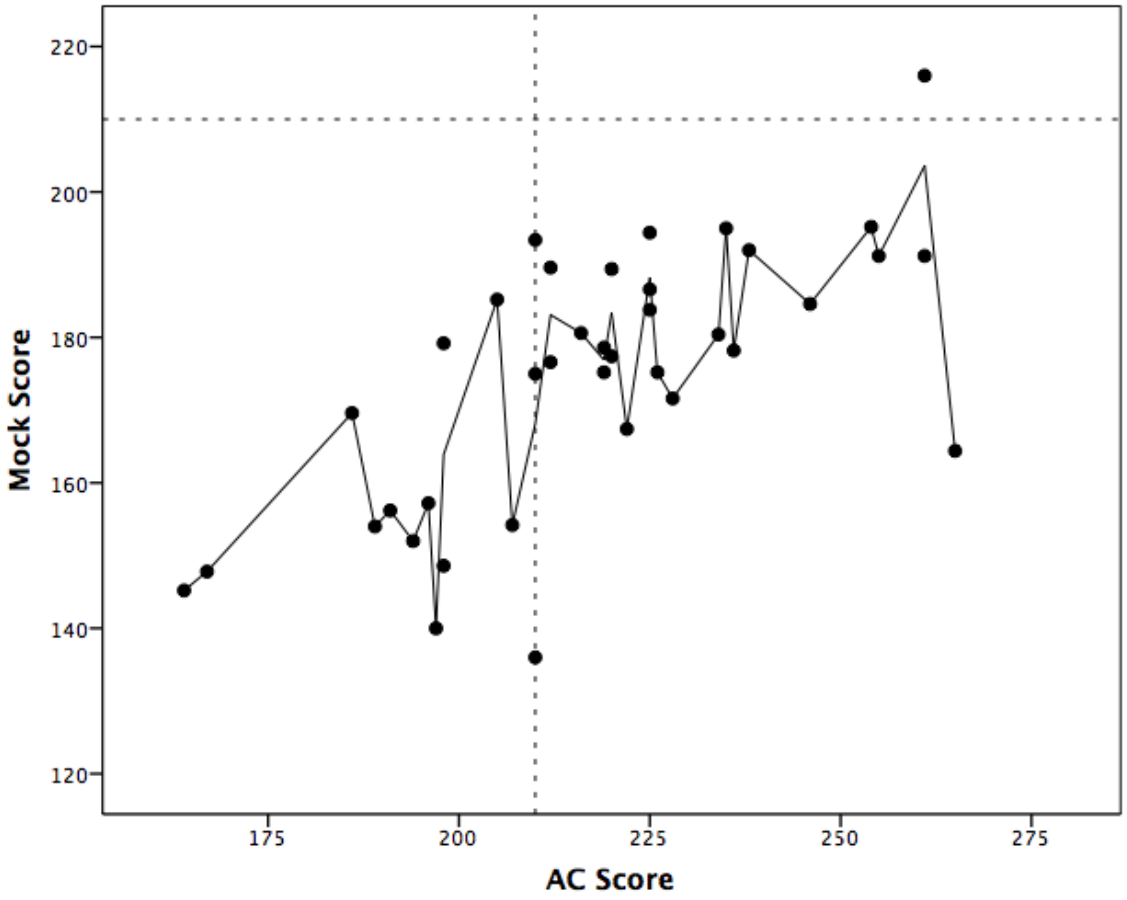

Figure 8. Scatterplot of AC Level 1 to Mock Exam Scores

The means of the AC Level 1 exam scores (horizontal axis) are illustrated in Figure 9 for all students who took the mock exam (vertical axis). The normal distribution of mean AC Level 1 scores reinforce the greater number of passing scores since only four bars (from the left of 210) exist of nonpassing AC Level 1 test results versus six bars (from the right of 210) of passing exam scores. The apex of the curve equals the mean test score on the AC Level 1 exam (M = 217.79, SE = 3.949), which exceeded the pass requirements of a score of 210, $t(37) = -14.938$, $p < .05$, $r = .681$.

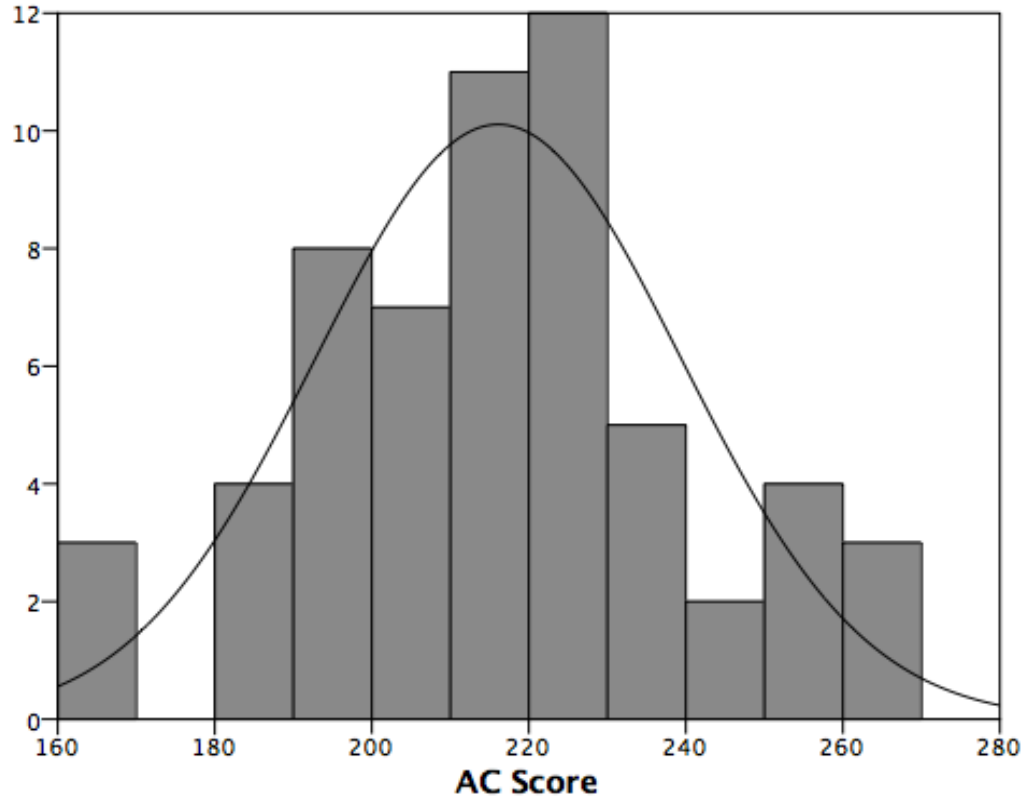

Figure 9. Distribution Curve—Means of Mock Examinees on the AC Level 1 Exam

Sample Descriptive Statistics and Differences between Mock vs. Non-Mock Students

Descriptive statistics present the characteristics of the study participants, which enable illumination of potential confounding variables as well as any future inferences of replicability with other post study environments. Table 9, below, illustrates ethnicity and age—all of the descriptive statistics gathered on the participants of this study. The most obvious comparison regarding the ethnicity of mock students is the misalignment with the university's ethnic distribution of students. The university demographics identify with a highly diverse race profile, while the students who participated in the mock exam

portray a two-race profile, predominately White and Hispanic. Upon closer inspection, the mock study students and the 2012 construction management enrollment demographics are similarly aligned with White and Hispanic representing dominant counts. The differences between university enrollments versus department/study enrollments may be attributed to the type of student interested in pursuing construction management as a career. With regard to this study, the most important inference is that the mock study students remained fairly representative of the overall construction management enrollment; thereby reducing the probability of a confounding variable characterized by race designation.

Table 9. Mock Student vs. University Enrollment Demographics

	Study Mock Students	**Const. Mgmt. 2012 Enrollment**	**University Fall 2012 Enrollment**
Race/Ethnicity	**%**	**%**	**%**
White	60	50	32.20
Hispanic	34	36	24.90
African American	3	6	12.20
Asian	3	8	19.20
International	0	0	8.90
Other & Unknown	0	0	2.70
Total	100	100	100

Table 10 includes both student parameter and performance statistics of interest to this study by comparing age, AC Level 1 exam scores, and mock exam scores where applicable. Regarding the age category, both groups of students are identical in average and median ages. Of significance when considering replicability to other programs, the senior-level student within this program is three to four years older than a conventional

program where most students enroll directly upon graduating from high school. The construction management program at the test university has a high population of working students, and classes are conducted in the evenings to facilitate this model. Replicability and expectancy of similar results should be approached with caution with respect to this student demographic. Observation of the most significant change between mock vs. non-mock students is the decline by non-mock students in the average and median AC Level 1 test scores. The five-point increase in AC Level 1 score by mock students demonstrates an increase in scores through participation in the mock exam between groups. Table 10 also re-emphasizes the average and median score increase by the mock students from the mock to the AC Level 1 exam, which was shown to be significant in the quantitative findings.

Table 10. Average and Median Scores of Mock vs. Non-mock Examinees

	Age	**AC Level 1 Score**	**Mock Score**
Mock Students			
Average	26	218	174
Median	25	219	178
Non-mock Students			
Average	26	213	N/A
Median	25	214	N/A

Student Survey Qualitative Findings

Survey Responses

In an effort to acquire input from the students who participated in the mock exam study as well as those who took the AC Level 1 exam without taking the mock exam, two survey questionnaires were administered. Both surveys were facilitated through Survey Monkey with anonymity protection to the respondents. The mock student participant survey results are revealed in Table 11 and were obtained immediately after taking the mock exam each semester. The number of completed surveys by the mock exam students totaled 37. When compared to the total number of mock examinees, 38 each, mock study input represents a response rate of 97%. Survey participants were unanimous in their responses regarding the mock exam's ability to strengthen understanding of areas needing improvement, thereby creating a beneficial condition through participation in the mock exam, and their willingness to promote the experience to other students. Lower planned participation percentages of outside professor-led study groups and use of Red Vector web-based application occurred from the first to the second semester.

Table 11. Post Mock Surveys

Participant Opinions	Post Mock Survey, Spring 2012			Post Mock Survey, Fall 2012		
	Participation	Beneficial	Strengthened Understanding	Participation	Beneficial	Strengthened Understanding
Identification of improvement areas through mock exam			100%			100%
Weakest areas (need 10 hours or more of study as discovered by mock)	41%			50%		
Believe mock exam was beneficial		100%			100%	
Recommend taking mock exam to other students		100%			100%	
Feel more confident about passing the AC level 1 exam		94%			75%	
Plan to participate in study group by outside professor	88%			65%		
Plan to participate in study group by Red Vector	100%			75%		
Perceive AC level 1 certification as an asset to resume		71%			90%	

The lower percentages in organized study activities were mirrored by lower confidence rankings of passing the AC Level 1 exam by students who participated in the mock exam. Between semester rankings increased, from 41% to 50%, where students intended to study more than 10 hours to strengthen their understanding of constructs they perceived were weak as a result of taking the mock exam. Lastly, students who participated in the mock exam perceived greater benefit to their resume upon graduation when looking to enhance their career in the construction industry with an increase from 71% to 90%.

Table 12 represents the students who took the AC Level 1 exam, with no restriction on their participation in the mock study. Regarding Table 12, a response rate of 93% was recorded with 55 out of 59 respondents, which represents all students who took the AC Level 1 exam for both semesters. Similar to the mock exam survey, the AC Level 1 questionnaire was administered immediately after students completed the AC Level 1 exam. Post AC Level 1 exam surveys failed to produce unanimous opinions from the students, dissimilar to the post mock survey. It is of interest to note that the number of students who participated in the mock exam increased from the first to second semester by 10%. Participation by AC Level 1 examinees in organized study groups with face-to-face instruction increased from semester one to semester two and produced the highest beneficial rankings, ranging from 72% to 89%. Between-semester rankings of the AC Level 1 constructs presented in non-capstone courses rose by 17%; however, the perceived benefit was predominately lower than rankings received for other professor-led organized study. The most contradictory response from students concerned the use of the Red Vector online learning platform, where there was a significant drop-off in use during the second semester by 34%. In light of the significant decline in use of Red Vector, those students who utilized the platform indicated positive results in strengthening their understanding by a range of 81%–89%. The study mode that wasn't made available to students in the post mock survey was ad hoc study groups amongst fellow students. The post AC Level 1 exam survey revealed that 67%–73% of students utilized ad hoc student study groups as an additional means to prepare for the exam. Lastly, a significant

percentage (89%–98%) of students indicated a desire to take the AC Level 1 exam in the semester previous to the capstone course.

Table 12. Post AC Level 1 Exam Surveys

	Post AC Level 1 Survey, Spring 2012			Post AC Level 1 Survey, Fall 2012		
Participant Opinions	Participation	Beneficial	Strengthened Understanding	Participation	Beneficial	Strengthened Understanding
Would like taking exam prior to capstone course		89%			98%	
Participated in mock exam	44%			54%		
Participated in study group led by non-capstone professor	61%	89%		65%	81%	
Participated in study group led by capstone class professor during class	56%	72%		73%	89%	
Participated in study group of student friends	67%			73%		
Participated in study group using Red Vector	72%	61%	89%	38%	43%	81%
Other professors included AC content in classroom review	61%	61%		78%	76%	

An open comment section was included in the Post AC Level 1 exam survey with specific constructive feedback from students as follows:

- Add YouTube videos as an instructional aid for the 10 constructs of the AC Level 1 exam.
- Make the mock exam available to all students who took the AC Level 1 exam in lieu of just those who were enrolled in the senior capstone course.

- Focus on AC Level 1 exam material in all classes of the construction management degree program.
- Provide variation in day of the week scheduling for the non-capstone professor led review sessions to enable students with scheduling conflicts to attend the sessions.
- Allow students who are not taking the capstone course to have access to Red Vector for the purpose of studying at least one semester prior to taking the AC Level 1 exam.

Common negative feedback from students after taking the AC Level 1 exam surrounded two central themes:

- Insufficient exposure to AC Level 1 constructs during the overall degree program.
- AC Level 1 content was too voluminous to include with other aspects of the capstone course.

One additional technique was implemented to assist in preparation for the AC Level 1 exam, by creating asynchronous communication between the capstone course professor and the students. This particular measure was facilitated through Blackboard Learn discussion board and facilitated ongoing Q&A regarding the 10 constructs on the AC Level 1 exam. As previously discussed, these measures were not implemented until after the mock exam each semester.

Survey Results

The response rates were high, with rates of 93% from all AC Level 1 examinees and 97% from mock exam participants. With a strong response rate, the input from these participants creates a realistic illustration of the perceptions exhibited during this quasi-experimental study. Upon review, some of the results seem intuitional and anticipated, while a few appear to be counterintuitive. The remainder of this discussion will review survey findings based upon the anticipated responses by the researcher and their potential impact on future studies.

Among those findings that were anticipated by the researcher, survey participants were unanimous in their responses regarding the mock exam's ability to strengthen understanding of areas needing improvement, thereby creating a beneficial condition through participation in the mock exam, and their willingness to promote the experience to other students. If a presumption is made that increased effort aligns with motivation to succeed, then it is plausible to expect that mock examinees would respond positively as to the benefits of the mock exam. The surprising element of this response is the unanimous agreement among all the mock examinees. Perhaps this finding demonstrates aspects of the Hawthorne effect among the mock examinees, where positive emotional effect is due to the perception of a sympathetic or interested observer, in this case the researcher, instructor, and the construction management department. It is possible that each participant could have felt that their participation was significant to the construction management department's efforts to increase passing rates, so there is a possibility that individually, the mock examinees could be exuding the Hawthorne effect. Conversely,

the timing of administering the mock exam survey would diminish the "group shared mentality" associated with the Hawthorne effect, since enlistment to take the exam was privately communicated through Blackboard and the survey was administered immediately following completion of the mock exam.

Another anticipated result was the desire by all responding students (AC Level 1 and mock exam) to take the AC Level 1 exam in the semester prior to the capstone course (89%–98%). Since 40% of the capstone course grade consisted of passing the AC Level 1 exam, most students wanted a pre-attempt at the actual AC Level 1 exam. The pressure created from this high-stakes exam, i.e., program graduation, influenced many students' beliefs that allowing more than one opportunity to take the AC Level 1 exam would lessen exam stress. While this is similar in concept to the mock exam, many students couldn't participate in the mock due to employment and family commitments. The model of multiple opportunities to take a high-stakes exam is replicated through administration of the national scholastic exams, i.e., ACT, SAT, GRE, et al.

An unanticipated result of the survey was the declining participation by students in both student- and outside professor-led study groups from the first to second semester of the study. The usage of the Red Vector web-based study application also experienced a drop in participation between semesters. The construction management administration provided the funding for the online preparation program so the decline in usage cannot be associated with cost. The lower percentages in the three preparation activities were mirrored by lower confidence rankings of mock exam students regarding their ability to pass the AC Level 1 exam. As confidence ratings and organized study methods were

dropping, student rates of intent to study more than 10 hours to strengthen their understanding of the exam constructs increased from 41% to 50%. The decline in usage of organized preparation activities in conjunction with the increase in study hours suggests that students planned to spend more time in individual preparation. The existence of student pressure associated with a high-stakes exam would typically infer that multiple preparation resources would be utilized; however, this study failed to support this premise.

Chapter V

Discussion and Implications

Nature of the Research

The original impetus for this study was borne out of the need to aid senior students in preparing for the AC Level 1 certification exam as a high-stakes prerequisite exam for graduation from the construction management program. Passing rates from the previous semesters had yielded a mere 50% pass rate, lower than the national average of comparable nation-wide programs who did not constrain the exam with the high-stakes program graduation requirement. The setting for this study was conducted within the construction management program of a state-funded, public university located in the southern United States and is considered on par with 67 other national university programs that also serve as testing facilities for the AC Level 1 certification exam.

Conceptualization of the quasi-experimental research revolved around the development of an AC Level 1 simulation exam or mock exam in an effort to re-create the exam process as closely as possible, while utilizing the mock exam as a preparation method and study treatment for the purpose of assessing whether it would positively improve AC Level 1 certification test scores. Research theorized that student awareness of the their weakest knowledge constructs prior to test preparation activities and minimization of anxiety, through familiarization of the testing process, might produce consistent passing scores on the AC Level 1 exam. Every attempt was made to simulate the exact conditions of the AC Level 1 testing process with exception of two aspects: adjustments were made in the number of questions for each of the 10 test constructs to

present more questions on historically weaker test results by previous examinees, and the mock exam was administered through BlackBoard in lieu of Scantron. The purpose of this study was to determine if a preponderance of evidence existed to support the claim that a mock exam, as a preparation technique, would enhance pass rates on the actual AC Level 1 certification exam for senior-level students in higher education construction programs. Transforming theory into an experimental design resulted in the following research questions:

- What are the differences between the scores for the construction management students who take both the mock exam and the AC Level 1 certification exam?
- What are students' perceptions of the mock exam as a preparation assessment instrument?

Preserving the integrity of the study required careful timing of the mock exam, relative to the other exam preparation methods. The mock exam was delivered to the volunteer students prior to any form of organized study in the first week of each semester to prevent other preparation efforts from convoluting the impact of the mock exam. Assessment of student perceptions also required specific timing on survey feedback from the examinees. Mock examinees (65% of all AC Level 1 examinees) provided feedback on the mock exam immediately following completion of the mock exam and all AC Level 1 examinees provided feedback within three days of taking the certification exam.

Evolution of the research design resulted in the hypothesis that students who take the mock exam experience a statistically significant improvement in passing scores on the AC Level 1 certification exam. The research attempts to determine a relationship of the

independent variable (mock exam pass/fail grade) on the dependent variable (actual AC Level 1 certification exam pass/fail grade). The pretest-posttest design within groups over time required that the posttest (AC Level 1 exam) be administered after the mock exam, resulting in a 13-week gap between treatment and dependent variable. Face and content validity were reviewed by the CCC (AC Level 1 testing board) and assessed that the mock exam did meet the intent of the AC Level 1 exam. Reliability of the mock exam as a testing instrument produced consistent results over the study's two-semester period, as the mean mock exam score was 177 in semester one and 171 in semester two. The six-point delta between semesters represents a 2% variation when compared to the mock exam's highest possible score of 300 points.

Quantitative Summary

On average, students who participated in the mock exam (M = 174.79, SE = 3.949) experienced a higher mean test score on the AC Level 1 exam (M = 217.79, SE = 3.949), which exceeded the pass requirements of a score of 210, $\mathbf{t}(37) = -14.938$, $\mathbf{p} < .05$, $\mathbf{r} = .681$. The findings of the statistical analysis appear to substantiate the hypothesis that a mock exam, as a preparation technique, enhances pass rates on the actual AC Level 1 certification exam for senior-level students. The study's methodology is consistent with quasi-experimental research techniques and contains all of the statistical markers necessary to imply a relationship between the mock exam and AC Level 1 exam where

- $p = .00$,
- the null hypothesis is rejected,

- mean AC Level 1 tests scores are above the passing score (217 vs. 210, respectively),
- a large effect size exists at $R = .926$,
- the confidence interval ($CI_{.95}$ –49,–37) excludes zero probability of the mock not having an effect with a confidence interval between –49 and –37 points, and
- Pearson's correlation coefficient equals 68%.

With $p = .00$ as a result in the dependent two-tailed *t*-test, the significance level indicates that this result can be replicated a vast majority of thetime when sampling from the population of this study and is not due to chance or sampling error. Additionally, rejection of the null hypothesis through the *t*-test analysis implies that the mock exam does have a positive effect on the actual AC test scores and it is plausible to assume that the mock exam was useful in improving student performance. Furthermore, the confidence interval indicates that the AC Level 1 scores improve from the mock exam scores within the range of 37 and 49 points and exclude the possibility of zero improvement. The large effect size of $R = .926$, per Cohen's model, suggest a high practical significance in utilizing the mock exam as a preparation technique for the AC Level 1 exam. Lastly, Pearson's correlation of $r = .681$ indicates a high linear trend exists relative to the ideal scatterplot of test scores, where +1 shows that all scores fall on a positive line. It is important to remember that this correlation coefficient does not imply causality, but rather indicates the relationship to a model of perfect test score distribution.

Correlational Summary

First-time AC Level 1 test students who were enrolled in the capstone course and participated in the mock exam experienced a higher percentage passing rate on the AC certification exam (Table 13). The data were accumulated over a two-semester period, with 38 volunteer participants choosing to take the mock exam within a total of 59 AC Level 1 examinees. The passing rate by mock examinees on the AC Level 1 exam (68%) represents a higher passing percentage demonstrated by national examinees (57%) for the same period (Table 14). The comparison between non-mock students pass rate in this study versus all national examinees yields an improvement in passing rates by mock students of 16% and 11%, respectively. Review of Tables 13 and 14 confirm the underachievement of non-mock students relative to national exam students by comparing the passing rates of 52% and 57%, respectively.

Table 13. Comparison of Mock Students vs. Non-Mock Students Pass/Fail Rates on AC Level 1 Exam in this Study

	Mock Exam Students	Non-Mock Exam Students	Differential Margin
Pass AC Level 1	68%	52%	16%
Fail AC Level 1	32%	48%	−16%

Table 14. Comparison of Mock Students vs. National Students Pass/Fail Rates on AC Level 1 Exam

	Mock Exam Students	National Non-Mock Exam Students	Differential Margin
Pass AC Level 1	68%	57%	11%
Fail AC Level 1	32%	43%	−11%

While increases in passing rates are compelling, proven statistical methods are required to indicate whether the preponderance of evidence points to valid and reliable support of the study's hypothesis. In summary, the study's methodology is consistent with quasi-experimental research techniques and all of the statistical markers; rejection of the null hypothesis, Pearson's correlation coefficient (68%), mean scores above the passing score (217 vs. 210, respectively), large effect size (.926), and the confidence interval excluding zero probability of the mock not having an effect (–49 to –37) are indicative of a positive correlation between the mock exam as a preparation technique and the AC Level 1 exam results.

Another attribute of the study, the mean age of study participants, may present higher than the national norm. With the mean (26) and median (25) ages, it may be important to evaluate the same demographics in future studies since most university construction management programs typically experience age ranges between 18 and 22. The university utilized for this study is located in a highly populated urban city with a thriving economy, where the construction industry contributes 14.5% of the employment population (U.S. Bureau of Labor Statistics, 2015). The local economy's need for construction staff may be a contributing factor to the older student demographic included in this study; but without further analysis, this is merely speculative.

Student Survey Summary

Observation of the most significant change between mock versus non-mock students was the decline by non-mock students in the average and median AC Level 1 test scores. Mock exam students demonstrated a five-point increase in AC Level 1 exam

score when compared to those students who didn't participate in the mock exam. Additionally, the passing rate by mock examinees on the AC Level 1 exam (68%) represents a higher pass percentage demonstrated by national examinees (57%) for the same period. Mock examinees yielded an improvement in passing rates for the AC Level 1 exam versus non-mock students from this study, and all national examinees by 16% and 11%, respectively.

Survey response rates were high, with rates of 93% from all AC Level 1 examinees and 97% from mock exam participants. Survey participants were unanimous in their responses regarding the mock exam's ability to strengthen understanding of areas needing improvement, thereby creating a beneficial condition through participation in the mock exam, and their willingness to promote the experience to other students.

Contribution to Existing Literature

Extensive research has been conducted on the effects of standardized testing and subsequent academic performance, but far less was found on the relationship of pretesting via a mock exam and its effect on the actual exit exam. Existing studies regarding exit exams from a university baccalaureate degree program were unable to be located after an in-depth search. As construction certification exams have only been in existence for a relatively short period of time, research on the combined topics of construction education and certification were also scarce. The researcher's intent was to reinforce the body of knowledge for the discipline of construction management, improve the related pedagogy to impart educational techniques for high-stakes exam preparation, and bridge the gap in construction certification literature.

Bernold (2005) focused his work on assessing the paradigm shift required in modern day construction education and posited that learning is enhanced when approached as a personal process of inquiry and not as a product of instruction. Student engagement becomes the primary building block in Bernold's model and this study was able to reinforce his theory. Participant surveys conducted post AC Level 1 exam indicate that student participation in non-capstone professor-led content review sessions ranged from 61% to 65% and other professor-led sessions ranged from 61% to 78%. Of greater significance were the student-led review sessions, which ranged from 67% to 73%, which illustrates examinee engagement in the learning process. Existence of these three non-class study sessions also reinforces personal adoption of the inquiry process. When these sessions are added to the capstone course learning activities, a learning community is created where, according to O'Banion (1997), cooperative learning is fostered and the student experiences active learning. In addition to this learning community, mock students indicated that 41%–50% of them intended to study more than 10 hours to strengthen their weakest areas as revealed by the mock exam. The intent of this survey result implies an internalization of the study process for improvement, which further supports Bernold's supposition regarding student engagement.

It is the researcher's hope that construction management education as it relates to high-stakes testing and competency-based learning has been strengthened by this study, as illustrated in Figure 10. For a comparison of anticipated progress, the perception of initial literature depth is illustrated in Figure 1 versus additional support for these concepts as a result of this study shown in Figure 10. However, knowledge is only

beneficial when it is used, so the desire is that this study's implications can be put to use at the other 67 construction management programs to benefit student learning.

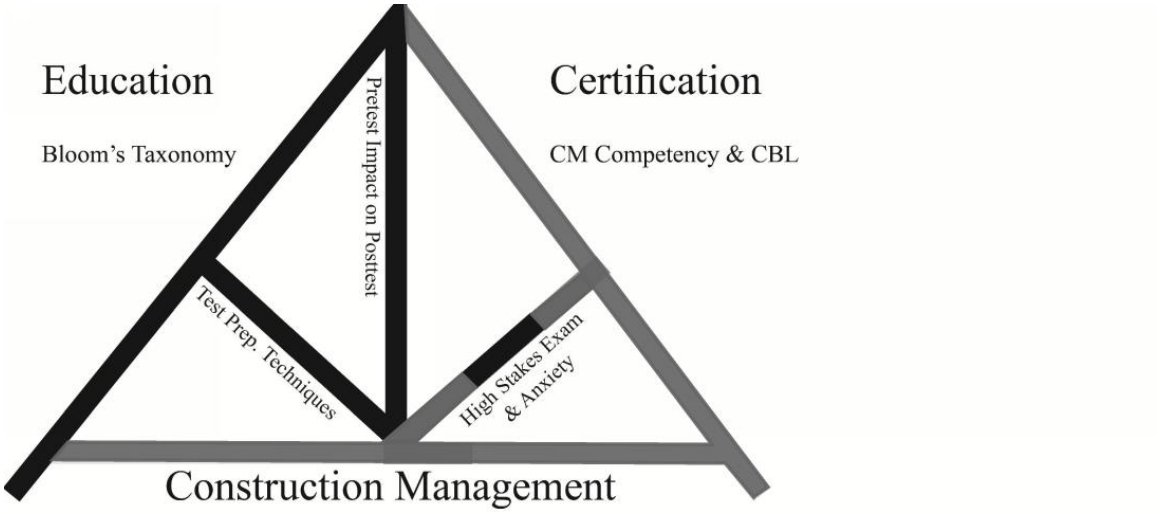

Figure 10. Study's Contribution to Literature

Implications

The Construction Industry and Credentialization

With the CCC reporting exam registration from 2012 through 2014 to fall to an average of 1,568 examinees per year from 2,500 in previous periods, the use of an additional study aid in the form of a mock exam could benefit professionals seeking certification. This posit does not imply that the certification exam would be easier, rather the preparation method would facilitate lower test anxiety and better student assessment of existing knowledge. In light of the U.S. Bureau of Labor Statistics' (2013) projections that the U.S. construction industry will grow by a rate of 4.1% through 2022, speculation of certification importance is plausible as a means to increase individual practitioner knowledge and identify top talent by employers. Regardless of either supposition, construction certification is in the infancy stage of development and all efforts to facilitate adoption and ease of implementation could support the endeavor.

Construction Management Programs and Academicians

Even though this body of work was not presented as a model, academicians could replicate many of the test preparation techniques that were implemented to assist students during this study. Post study reflection points to student self-awareness through utilization of the mock exam and diverse preparation activities as key elements in fostering student success. While this research focuses on student self-actualization, it is equally important to acknowledge the role of the academician as one who establishes the many study programs and facilitates a positive learning environment. It is the

researcher's observation that many small steps (i.e., Blackboard discussion boards for asynchronous communication between student and professor, multiple organized activities to provide greater flexibility in student schedules, increased problem solving exercises both in and outside of class, provision of study notes prior to classroom instruction, reduction of content into smaller modules to reduce student anxiety, utilization of web technology and videography to transmit class materials and exercises on a real time basis) were contributing factors to student performance. And, the mock exam quantifiably facilitated improvement in meeting the final goal of passing the AC Level 1 exam, serving as a reference point for examinees' weakest knowledge areas, a stress reducer based upon exam familiarity, and a motivational point to begin semester long preparation. Regardless of replicability issues, based upon other construction management programs not treating the AC Level 1 exam as a high-stakes exit exam, the mock exam could be implemented as an aid to students.

This study provides multiple opportunities for practical application in any institutional program, which employs high stakes testing. And yet, this study would be incomplete without acknowledging the theoretical concepts of culture development for student success. Whether the students are employees of industry seeking professional certification or working to complete a higher education degree, it is important to establish an environment that continually reinforces the desired educational outcomes. As demonstrated by this study, this can be achieved via multiple methods, i.e., providing a variety of study sessions that facilitate student schedule flexibility, organized feedback from students on a regular basis, prompt and clear response from instructors regarding

student questions, and consistent presentation of the educational materials across multiple platforms. All of these actions create momentum when faculty, students, and administrators are focused and in alignment with the desired objective; passing the AC Level 1 exam or other similar educational goals.

Future Research

Since there is not an abundance of research concerning the cross section of construction management education and individual certification, it is the researcher's aspiration that this study can serve as a launching point for future research. Based upon the literature review conducted for this study, it is the researcher's observation that other industries have excelled in facilitating experimental data regarding professional certification and the construction industry appears to be lagging behind. With the increased demand for future construction professionals the relatively new era of certification could not only bolster competency but also improve upon stature within the industry.

The limitations of this study did not allow statistical analysis beyond percentages of performance for grade point averages. Nor were non-mock student scores compared to mock examinees through a statistical experiment. With suitable planning, statistical model comparisons of mock vs. non-mock scores could provide further illumination on the benefits of the mock exam as a treatment measure. Also, not included in this study were measurements of student motivation and awareness by both mock and non-mock examinees. Several existing survey measurements exist to assess student motivation and

self-awareness and could illuminate deeper implications of students who voluntarily chose to participate in the mock exam versus those who do not participate.

The researcher would welcome the opportunity to aid in implementing the mock exam in other construction management programs. Construction has been responsible for development of our society's infrastructure, housing, and buildings used by the population. The relatively small amount of time to develop the talents of those professionals, who will carry forward these duties for the future of humanity, seems to be a wise investment.

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APPENDIX A

University of Houston Institutional Review Board Approval

UNIVERSITY OF HOUSTON
Division of Research
Institutional Review Board Application

Generated at: 1/2/2013 11:55:38 AM

Institutional Review Board Application ID :	13178-EX - (2780)
Title :	Analysis of undergraduate student success with the National AIC certification exam and research of various preparatory programs to assess improvement in AIC scores.

Approval details for the Application Id: 2780

	Decision	Approver Name	Date	Comment
PI signature	Approved	Coble, Lana Ms.	12/20/2012	The application has been amended to meet institutional guidelines per feedback from DOR.
DOR signature	Approved	Admin, IRB	12/20/2012	

Application Data for Application ID: 2780

Title	Analysis of undergraduate student success with the National AIC certification exam and research of various preparatory programs to assess improvement in AIC scores.
Application Type	New
Review Type	Exempt
Expedite Code	Not Applicable
Exemption Code	4: Research involving the collection/study of data
Research Reason	Candidacy/Professional Paper,Doctoral Dissertation

Investigator Data for Application ID: 2780

PI Name	Is Pricipal?	Is Co-Investigator?	Is External?	Other Personnel Type?	Is Student?	Faculty Sponsor Name
Coble, Lana Ms.	Yes		No		Yes	McNeil, Sara G. Dr.
McNeil, Sara G. Dr.			No	Thesis Committe Member	No	Not Applicable

Project Review Summary Data for Application ID: 2780

Question	Answer
4) State the specific research hypotheses or questions to be addressed in this study	The purpose of the research is to evaluate retrospective data regarding the effectiveness of each of the internally designed six preparation programs to ready students for the American Institute of Constructors (AIC) National Certification Exam and to determine what impact these programs have on students successfully passing the exam. The construction management program mandates that all students must pass the AIC exam in order to graduate with a B.S. in Construction. The exam was administered by the American Institute of Constructors and is affiliated with the American Council for Construction Education, which certifies the construction management program at the University of Houston. The AIC exam is the final exam for construction management majors in the capstone course, CNST 4331. Students taking the CNST 3331 class have the option to take the exam prior to taking CNST 4331. The exam is pass/fail and covers a broad spectrum of construction management principles. Student AIC test scores will be compared to any of the six preparation programs that they chose to participate in prior to taking the test. This study will use two methods analyzing the impact of these preparation programs: 1. an online questionnaire to determine students involvement and recommendations for improvement and 2. The actual exam scores of students who took the exam from the Fall of 2010 through the Fall of 2012. It should be noted that all data is archival as the tests and questionnaires were completed as part of the coursework for each class. In addition to the composite score, 10 knowledge categories scores will be analyzed to determine which areas are in need of improvement in the construction management program to facilitate student success.
	The research will help us understand the approach that each student chose to

5) What is the importance/significance of the knowledge that may result?	take in preparing for the exam and which methods they preferred. The findings will also help us identify which methods are more successful in producing passing scores. With this knowledge, we can recommend improvements and identify those preparations, which are most effective to aid the students in passing the exam on their first attempt.
6) Type of Subject Population (check all that are appropriate)	UH Faculty, Staff, or Students
6.01) Expected maximum number of participants	350
6.02) Age of proposed subject(s) (check all that apply)	Adults (18yrs-64yrs)
6.03) Inclusion Criteria:	All students previously enrolled, including the range of Fall of 2010 through Fall of 2012, in the CNST 4331 Construction Management II course and those who opted to take the exam early in the CNST 3331 course during the same period. Acquisition of the AIC test scores has been completed as they were used as the final exam. The foundation for the research project is based upon the required AIC test and the voluntary feedback questionnaire that was included in the coursework for both classes. It should be noted that all students grant consent for the construction management program to receive their AIC scores during the exam registration process so the grade can be used for their final exam in CNST 4331.
6.04) Exclusion Criteria:	Students who did not take the AIC exam in the construction management program during the Fall 2010 through Fall 2012 period. Per the statement in the inclusion criteria, only students enrolled in CNST 4331 and voluntary students in CNST 3331 who apply the option to take the AIC exam prior to CNST 4331 were eligible to participate in the AIC exam.
6.05) Justification:	The study focuses on investigating the correlations between student preparation and learning with specific regard to passing the AIC exam.
6.06) Determination:	Enrollment in the course CNST 4331 from the Fall of 2010 through the Fall semester of 2012 and those students in CNST 3331, through the same period who voluntarily took the AIC exam before it is required in CNST 4331.
7) If this study proposes to include children, this inclusion must meet one of the following criterion for risk/benefits assessment according to the federal regulations (45 CFR 46, subpart D). Check the appropriate box:	
8) If the research involves any of the following, check all that are appropriate:	Study of Existing Data
9) Location(s) of Research Activities:	UH campus
10) Informed Consent of Subjects: Your study protocol must clearly address one of the following areas:	No Informed Consent. You may request a waiver of informed consent with Appendix B - Request for Waiver/Modification of Informed Consent. If applicable, a copy of the modified consent document is required. ATTACH APPENDIX B.

Research Protocol Data for Application ID: 2780

Question	Answer
	Both qualitative and quantitative research methods will be used to analyze the retrospective data in this study. Students who took the AIC National exam

11) Describe the research study design. (Describe the research methods to be employed and the variables to be studied. Include a description of the data collection techniques and/or the statistical methods to be employed.)	each semester were asked to voluntarily complete an online, secure questionnaire. Content analysis will be employed to deduce variables used for learning and preparation based on self-determination theory for the qualitative analysis. The quantitative research will include the students AIC pass/fail score, their performance for each of the 10 knowledge areas, and the preparation tools they employed prior to taking the test. Ancova, Anova and correlational analysis will be performed with SPSS software to analyze quantitative data and present results of the study.
12) Describe each task subjects will be asked to perform.	There are no tasks that the students will be asked to perform as all information to be evaluated is archival data. As stated previously, the AIC exam and the questionnaire are part of the normal coursework. The data used will utilize an identifier assigned by AIC, not personal identifiers such as student name or People soft numbers. The voluntary questionnaire was administered after students completed the AIC exam.
13) Describe how potential subjects will be identified and recruited? (Attach a script or outline of all information that will be provided to potential subjects. Include a copy of all written solicitation, recruitment ad, and/or outline for oral presentation.)	As the information is archival data there will be no recruitment required. All information to be evaluated was included as part of the normal coursework for the class.
14) Describe the process for obtaining informed consent and/or assent. How will investigators ensure that each subjects participation will be voluntary (i.e., free of direct or implied coercion)?	There will be no process for obtaining consent as all data is archival in nature and part of normal coursework completed.
15) Briefly describe each measurement instrument to be used in this study (e.g., questionnaires, surveys, tests, interview questions, observational procedures, or other instruments) AND attach to the application a copy of each (appropriately labeled and collated). If any are omitted, please explain.	The online questionnaire was the only instrument used that provides the qualitative measure of the study. The complete survey is attached and can be viewed online at the following website: http://www.instant.ly/s/WqdxYsAeYAA The AIC National office has supplied the quantitative data via a secure password protected report approximately 3 weeks after each AIC exam. Note that the exam is administered once in the Fall and the Spring of each year. The archival data for this research study includes the following semesters: Fall 2010, Spring 2011, Fall 2011, Spring 2012 and Fall 2012.
16) Describe the setting and mode for administering any materials listed in question 15 (e.g., telephone, one-on-one, group). Include the duration, intervals of administration, and amount of time required for each survey/procedure. Also describe how you plan to maintain privacy and confidentiality during the administration.	The qualitative questionnaire can be found at the following link: http://www.instant.ly/s/WqdxYsAeYAA . As stated previously, all data is archival in nature and were included as necessary coursework for the classes which participated in the AIC exam. Regarding the process for the secure online survey, it was available online for approximately two weeks after the AIC exam each semester. Students completed this confidential and secure questionnaire from any computer, which had internet access, and at any location. The identifiers in the survey were their people-soft number so that it could be coded to the AIC identifier number. The people-soft numbers will then be destroyed to preserve the anonymity of the participants. This linking between the survey and test results is important so that any correlation between preparation and test performance can be assessed. Any data included in the final research product will exclude all identifiers and will only be referred to as groups which participated in the various preparation programs.
17) Approximately how much time will be required of each subject? Provide both a total time	There is no time requirement for students as the data is all retrospective and

commitment as well as a time commitment for each visit/session.	complete.
18) Will Subjects experience any possible risks involved with participation in this project?	
18.01) Risk of Physical Discomfort or Harm	No:
18.02) Risk of Psychological Harm (including stress/discomfort)	No:
18.03) Risk of Legal Actions (such as criminal prosecution or civil sanctions)	No:
18.04) Risk of Harm to Social Status (such as loss of friendship)	No:
18.05) Risk of Harm to Employment Status	No:
18.06) Other Risks	No:
19) Does the research involve any of these possible risks or harms to subjects? Check all that apply.	Other (Explain): :No risk or harm
20) What benefits, if any, can the subject expect from their participation?	There is no direct benefit to participants from the survey as they have completed the coursework for the classes. The benefit will be to future students in the construction management program as the results of the study will hopefully provide further development of more effective preparation materials.
21) What inducements or rewards (e.g., financial compensation, extra credit, and other incentives), if any, will be offered to potential subjects for their participation?	None

Research Data for Application ID: 2780

Question	Answer
22) Will you record any direct identifiers, names, social security numbers, addresses, telephone numbers, patient or student ID numbers, etc.?	No: :No. While the researcher has access to the identifiers (peoplesoft numbers) as part of the construction management program, data will be abstracted for the research without identifiers in the following manner: a. the qualitative surveys include the students peoplesoft numbers but will be replaced with the corresponding AIC code. b. the test results are submitted with the AIC code for each student, so the name of each student will be removed from the AIC Test reports. c. Only the AIC code will remain for all archival data and all analysis will utilize the AIC code, which carries no significance to anyone outside the testing field. d. Any and all findings will not include personal student identifiers.
23) Will you retain a link between study code numbers and direct identifiers after the data collection is complete?	No:
24) Will anyone outside the research team have access to the links or identifiers?	No:
25) Where, how long, and in what format (such as paper, digital or electronic media, video, audio or photographic) will data be kept? In addition, describe what security provisions will be taken to	All questionnaire results will be downloaded from the host website and will

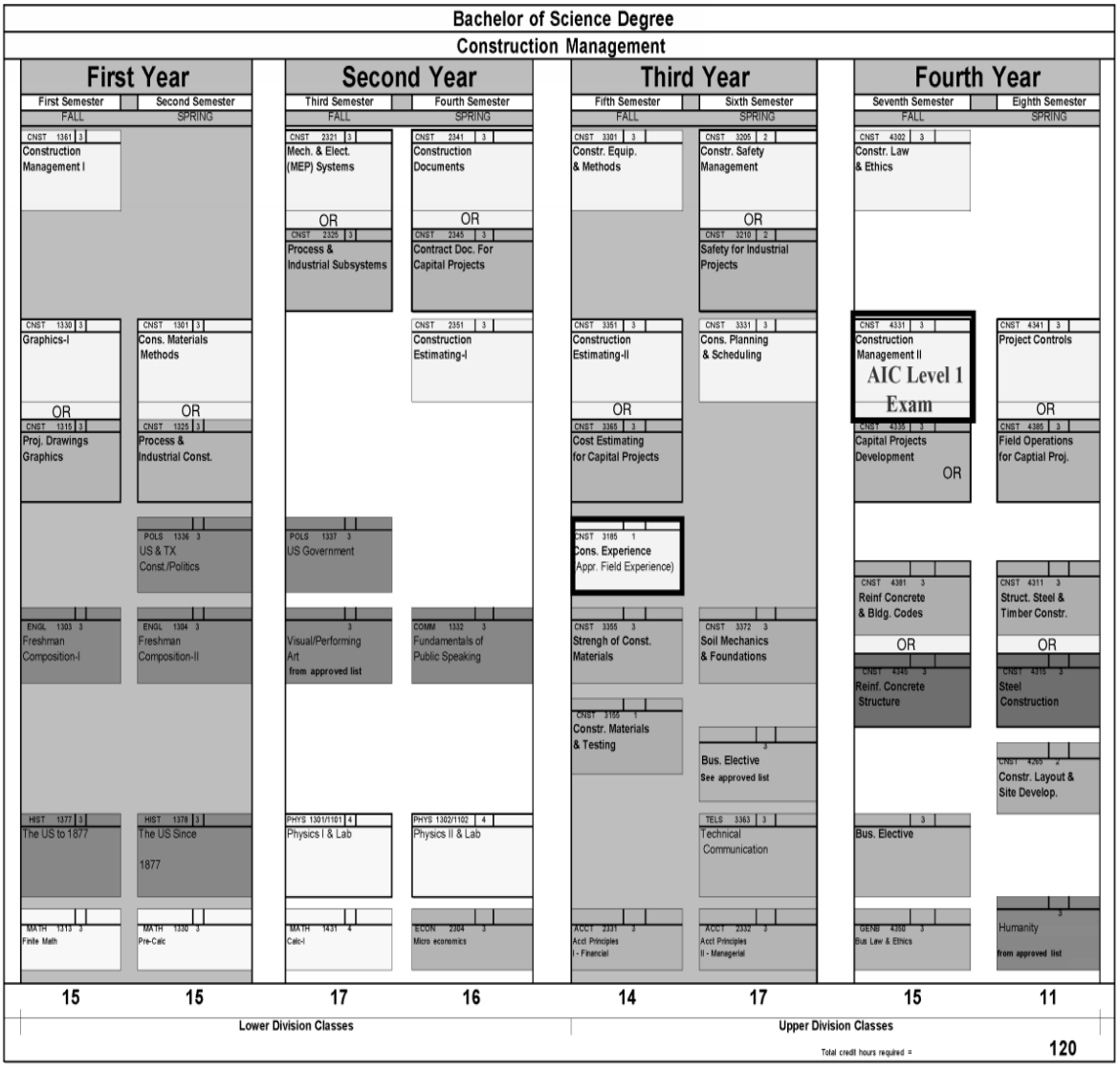
protect these data (password protection, encryption, etc.). [Note: University of Houston policy on data retention requires that research data be maintained for a minimum of 3 years after completion of the project. All research data collected during this project is subject to the University of Houston data retention policy found at http://www.research.uh.edu/Home/Division-of-Research/Research-Services/Research-Policies/Access-to-and-Retention-of-Research-Data.aspx]	be stored on a secure password protected excel file on a secure server for 5 years in the College of Education. The AIC results will be imported into SPSS with the AIC identifier code and all other documentation with student names will be destroyed. Please note that all SPSS data will be password protected. The server is in compliance with the University of Houston security policies. Any printed results of the study will be stored for at least a period of 3 years after completion of the project in Dr. Sara McNeil¿s office in a locked cabinet.

Appendix B Data for Application ID: 2780

Question	Answer
27) Does the proposed research, in its entirety, involve greater than minimal risk? (Minimal risk is defined as the probability and magnitude of harm or discomfort anticipated in the research which are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.) (If yes, your study is ineligible for waiver of informed consent under 45 CFR 46.116(d).)	No:
28) Could the proposed research be practically carried out without the waiver? (If yes, your study is ineligible for waiver of informed consent. OR If no, please explain)	No: :No, the students involved in the study are no longer at the College, and therefore it is not possible to contact all subjects for consent.
29) Will the requested waiver of informed consent affect the rights and welfare of the subjects? (If yes, your study is ineligible for waiver of informed consent. OR If no, please explain)	No: :The research will have no effect on the rights or welfare of the subjects as subjects have already completed the course (so cannot effect grades, etc) and moved forward into their careers.
30) If applicable, will pertinent information be provided to subjects later? (If yes, please explain OR If no, your study is ineligible for waiver of informed consent)	Yes: :This is not applicable because at the time the data is abstracted, students are no longer in the construction management program at UH, therefore the outcome cannot affect their academic or professional career, and yet it will be provided to the Department to benefit FUTURE students in the program.

APPENDIX B

B.S. Construction Management Curriculum



Comparison of Related Project Management Certifications[a]

Certificate Name	Agency	Professional Level	Certificate Focus	Questions	Hours
Certified Associate in Project Management	PMI	High school diploma	Project management	150	3
Project Management Professional	PMI	B.S. degree or 3 years' Experience	Project management	200	4
Certified Construction Manager	CMAA	B.S. degree plus 4 years' experience	Construction project management, time, quality, cost, and contract management	200	6[b]
Associate Constructor Level 1	AIC	B.S. Degree or 4 years' experience	Construction project management, cost, and schedule management	300	8
Certified Professional Constructor Level 2	AIC	AC Level 1 plus 2 years of managing work	Construction project management, schedule, cost, and contract management	250	8

[a] Compiled from Remer and Martin (2009).

APPENDIX C

ANSI Certified Programs 2014

PERSONNEL
ANSI/ISO/IEC 17024

Overview
Benefits of Accreditation
US Government Recognition
International Recognition
How to Apply
ANSI/ISO/IEC 17024 Workshop
Informational Visits
Policies & Procedures
Forms & Guidance Documents
PCAC Accreditation Committee
Accreditation Directory
Key Program Staff
FAQs

ANSI/ISO/IEC 17024 (Accredited)

« Back

#	ORGANIZATION	ID
1	American Board of Industrial Hygiene	0766
	Certified Industrial Hygienist (CIH)	
2	American Board of Multiple Specialties in Podiatry	0672
	Diabetic Foot Wounds and Foot Wear	
	Limb Preservation and Salvage	
	Podiatric Surgery	
	Primary Care in Podiatric Medicine	
3	American Institute of Constructors	1067
	Associate Constructor	
	Certified Professional Constructor	
4	American Registry for Diagnostic Medical Sonography	0674
	Registered Diagnostic Cardiac Sonographer	
	Registered Diagnostic Medical Sonographer	
	Registered Physician in Vascular Interpretation (RPVI)	
	Registered Vascular Technologist	
5	American Society for Clinical Pathology	0688
	Cytotechnologist, CT(ASCP)	
	Diplomate in Laboratory Management, DLM(ASCP)	
	Donor Phlebotomy Technician, DPT(ASCP)	
	Histotechnician, HT(ASCP)	
	Histotechnologist, HTL(ASCP)	
	Medical Laboratory Scientist, MLS(ASCP)	
	Medical Laboratory Technician, MLT(ASCP)	
	Pathologists' Assistant, PA (ASCP)	
	Phlebotomy Technician, PBT(ASCP)	
	Specialist in Blood Banking, SBB(ASCP)	
	Specialist in Chemistry, SC(ASCP)	
	Specialist in Cytotechnology, SCT(ASCP)	
	Specialist in Hematology, SH(ASCP)	
	Specialist in Microbiology, SM(ASCP)	
	Technologist in Blood Banking, BB(ASCP)	
	Technologist in Chemistry, C(ASCP)	
	Technologist in Cytogenetics, CG(ASCP)	
	Technologist in Hematology, H(ASCP)	
	Technologist in Microbiology, M(ASCP)	
	Technologist in Molecular Biology, MB(ASCP)	
6	American Society for Nondestructive Testing	0644
	ASNT NDT Level III Program	
	Industrial Radiography Radiation Safety Personnel (IRRSP) Program	
7	ASIS International	0714
	Certified Protection Professional (CPP)	
	Physical Security Professional (PSP)	
	Professional Certified Investigator (PCI)	
8	Association of Energy Engineers	1088
	Certified Energy Manager® - CEM®	
9	Board of Certified Safety Professionals	0646
	Certified Safety Professional® (CSP®)	
10	Building Performance Institute, Inc.	0985
	Crew Leader	
	Energy Auditor Certification	
	Quality Control Inspector Certification	
	Retrofit Installer Technician	
11	Cardiovascular Credentialing International	0777
	Certified Cardiographic Technician (CCT)	
	Certified Rhythm Analysis Technician (CRAT)	

	Registered Cardiac Electrophysiology Specialist (RCES)	
	Registered Cardiac Sonographer (RCS)	
	Registered Cardiovascular Invasive Specialist (RCIS)	
	Registered Congenital Cardiac Sonographer (RCCS)	
	Registered Phlebology Sonographer (RPhS)	
	Registered Vascular Specialist (RVS)	
12	**Cisco Systems**	**0734**
	CCNA (Cisco Certified Network Associate) Route and Switch	
	CCNP (Cisco Certified Network Professional) Route and Switch	
	Cisco Certified Network Associate Security (CCNA Security)	
	Cisco Certified Network Professional Security (CCNP Security)	
13	**Computing Technology Industry Association (CompTIA)**	**0731**
	CompTIA A+ ce	
	CompTIA Advanced Security Practitioner (CASP)	
	CompTIA Network+ ce	
	CompTIA Security+ ce	
14	**Construction Manager Certification Institute**	**0711**
	Certified Construction Manager (CCM)	
15	**Crane Institute of America Certification**	**1068**
	Crane Operator: Large Telescoping Boom Crane, Over 75 Tons	
	Crane Operator: Lattice Boom Crawler/Truck Crane, 1-300 Tons	
	Crane Operator: Medium Telescoping Boom Crane, 21-75 Tons	
	Crane Operator: Small Telescoping Boom Crane, Under 21 Tons	
16	**CSA America**	**0779**
	CNG Fuel System Inspector Certification	
17	**Global Information Assurance Certification (GIAC)**	**0727**
	GIAC Certified Enterprise Defender (GCED)	
	GIAC Certified Forensic Examiner (GCFE)	
	GIAC Certified Forensics Analyst (GCFA)	
	GIAC Certified Incident Handler (GCIH)	
	GIAC Certified Intrusion Analyst (GCIA)	
	GIAC Global Industrial Cyber Security Professional (GICSP)	
	GIAC Mobile Device Security Analyst (GMOB)	
	GIAC Penetration Tester (GPEN)	
	GIAC Security Essentials Certified (GSEC)	
	GIAC Security Leadership Certification (GSLC)	
	GIAC Systems and Network Auditor (GSNA)	
18	**Green Advantage Inc.**	**1048**
	Green Advantage Certified Practitioner (GACP)	
19	**Green Building Certification Institute**	**0863**
	LEED AP Building Design + Construction	
	LEED AP Homes	
	LEED AP Interior Design + Construction	
	LEED AP Neighborhood Development	
	LEED AP Operations + Maintenance (O+M)	
	LEED Green Associate	
20	**Healthy Children Project, Inc./Academy of Lactation Policy and Practice**	**0908**
	Certified Lactation Counselor (CLC)	
21	**InfoComm International**	**0770**
	Certified Technology Specialist (CTS)	
	Certified Technology Specialist - Design (CTS-D)	
	Certified Technology Specialist - Installation (CTS-I)	
22	**Information Systems Audit and Control Association**	**0694**
	Certified In Risk and Information Systems Control (CRISC)	
	Certified in the Governance of Enterprise IT (CGEIT)	
	Certified Information Security Manager (CISM)	
	Certified Information Systems Auditor (CISA)	
23	**Institute for Energy Management Professionals**	**1079**
	Certified Practitioner in Energy Management Systems (CP EnMS)	
24	**Institute of Certified Construction Industry Financial Professionals, Inc.**	**1121**
	Certified Construction Industry Financial Professional - CCIFP	
25	**Institute of Hazardous Materials Management**	**0893**
	Certified Hazardous Materials Manager (CHMM)	
	Certified Hazardous Materials Practitioner (CHMP)	
26	**International Association of Healthcare Central Service Materiel Management**	**1146**
	Certified Registered Central Service Technician (CRCST)	
27	**International Board of Heart Rhythm Examiners**	**0787**

	Certification Examination for Competency in Cardiac Electrophysiology for the Allied Professional	
	Certification Examination for Competency in Cardiac Rhythm Device Therapy for the Allied Professional	
	Certification Examination for Competency in Cardiac Rhythm Device Therapy for the Physician	
28	**International Council of E-Commerce Consultants**	**0732**
	Certified Ethical Hacker v8	
29	**International Information Systems Security Certification Consortium, Inc. (ISC)2**	**0668**
	Certification and Accreditation Professional (CAP)	
	Certified Information Systems Security Professional (CISSP)	
	Certified Secure Software Lifecycle Professional (CSSLP)	
	Information Systems Security Architecture Professional (ISSAP)	
	Information Systems Security Engineering Professional (ISSEP)	
	Information Systems Security Management Professional (ISSMP)	
	Systems Security Certified Practitioner (SSCP)	
30	**International Society of Arboriculture**	**0847**
	ISA Certified Arborist	
31	**Investment Management Consultants Association**	**1005**
	Certified Investment Management Analyst℠ (CIMA®)	
32	**LIUNA Training and Education Fund**	**1078**
	LIUNA Instructor	
33	**Manufacturing Skill Standards Council**	**0849**
	MSSC-Certified Logistics Technician (CLT)	
	MSSC-Certified Production Technician (CPT-AE)	
34	**Moody's Analytics Global Education (Canada), Inc DBA Canadian Securities Institute**	**0982**
	PFP®	
35	**NAESA International**	**1089**
	Inspector Supervisor	
	Qualified Elevator Inspectors	
36	**National Association of Elevator Contractors**	**0666**
	Certified Elevator Technician	
37	**National Board for Certification in Occupational Therapy, Inc.**	**0648**
	Certified Occupational Therapy Assistant (COTA)	
	Occupational Therapist Registered (OTR)	
38	**National Center for Construction Education and Research**	**0763**
	Crawler Mount Crane	
	Industrial/All Purpose Crane	
	Rough Terrain/All Terrain	
	Rubber Tire Truck Mount Crane	
39	**National Commission for Certification of Crane Operators**	**0756**
	Articulating Crane Operator	
	Crane Inspector	
	Digger Derrick Operator	
	Mobile Crane Operator	
	Overhead Crane Operator	
	Rigger	
	Rigger Level II	
	Signalperson	
	Tower Crane Operator	
40	**National Elevator Industry Educational Program**	**1044**
	Certified Signal Person and Rigger Level 1 (CSPR-1)	
	Certified Signal Person and Rigger Level 2 (CSPR-2)	
41	**National Fire Protection Association**	**0709**
	Certified Fire Protection Specialist (CFPS)	
42	**National Inspection Testing Certification Corporation**	**0645**
	HVAC Mastery Certification	
	Medical Gas Installer	
	Medical Gas Instructor	
	Medical Gas Verifier	
43	**National Registry of Food Safety Professionals**	**0656**
	International Certified Food Safety Manager (ICFSM)	
44	**North American Board of Certified Energy Practitioners**	**0702**
	Certified Solar PV Installer	
	Solar Heating Installer Certification	
45	**Professional Evaluation and Certification Board**	**1003**
	CLFE-Certified Lead Forensics Examiner	
	ISO 14001 Lead Auditor	
	ISO 14001 Lead Implementer	
	ISO 14001 Master	

	ISO 20000 Lead Auditor	
	ISO 20000 Lead Implementer	
	ISO 20000 Master	
	ISO 22000 Lead Auditor	
	ISO 22000 Lead Implementer	
	ISO 22000 Master	
	ISO 22301 Lead Auditor	
	ISO 22301 Lead Implementer	
	ISO 22301 Master	
	ISO 26000 Lead Auditor	
	ISO 26000 Lead Implementer	
	ISO 26000 Master	
	ISO 27001 Lead Auditor	
	ISO 27001 Lead Implementer	
	ISO 27001 Master	
	ISO 27002 Manager	
	ISO 27005 Risk Manager	
	ISO 28000 Lead Auditor	
	ISO 28000 Lead Implementer	
	ISO 28000 Master	
	ISO 31000 Risk Manager	
	ISO 9001 Lead Auditor	
	ISO 9001 Lead Implementer	
	ISO 9001 Master	
	OHSAS 18001 Lead Auditor	
	OHSAS 18001 Lead Implementer	
	OHSAS18001 Master	
46	**Project Management Institute**	**0705**
	Project Management Professional, PMP®	
47	**Qualified Elevator Inspector Training Fund**	**1090**
	Certified Elevator Inspector	
48	**Refrigerating Engineers & Technicians Association**	**0738**
	Certified Assistant Refrigeration Operator	
	Certified Industrial Refrigeration Operator	
49	**Society for Maintenance and Reliability Professionals Certifying Organization**	**0739**
	Certification for Maintenance and Reliability Professionals (CMRP)	
50	**Society of Industrial Security Professionals**	**0860**
	Industrial Security Professional	
51	**Testing, Adjusting and Balancing Bureau**	**0728**
	ICB FLS Level 1 Supervisor	
	ICB FLS Level 1 Technician	
	ICB FLS Level 2 Supervisor	
	ICB FLS Level 2 Technician	
	ICB TABB Supervisor	
	ICB TABB Technician	
52	**Vibration Institute**	**0845**
	Vibration Analyst	

APPENDIX D

Comparison of ACCE vs. AC Level 1 Universities

ACCE	AC Level 1
Alfred State	Alfred State
Arizona State	Arizona State
Auburn	Auburn
Ball State	
Boise State	Boise State
Bowling Green	Bowling Green
Bradley	
	Brigham Young
Caly Poly	
	Cal Baptist University
Cal State, Chico	Cal State, Chico
Cal State, Fresno	Cal State, Fresno
Cal State, Long Beach	
Cal State, Northridge	Cal State, Northridge
Cal State, Sacramento	Cal State, Sacramento
Central Connecticut	Central Connecticut
Central Washington	Central Washington
Clemson	Clemson
	Colorado Mesa University
Colorado State	Colorado State
Drexel	
East Carolina	
Eastern Kentucky	Eastern Kentucky
Eastern Michigan	Eastern Michigan
Ferris State	Ferris State
Florida International	
Georgia Tech	
Georgia Southern	
Illinois State	Illinois State
Indiana State	
John Brown	John Brown
Kansas State	
	Kent State
Lamar	
LSU	LSU
Michigan State	Michigan State

ACCE	AC Level 1
Milwaukee School of Engineering	Milwaukee School of Engineering
Minnesota State, Mankato	Minnesota State, Mankato
Minnesota State, Moorhead	Minnesota State, Moorhead
Missouri State	Missouri State
	Montana State
	Murray State
North Carolina A&T State	
North Dakota State	North Dakota State
	North Lake College
Northern Arizona	Northern Arizona
Northern Kentucky	Northern Kentucky
	Norwich University
	Oklahoma State
Oregon State	
Pennsylvania College of Technology	Pennsylvania College of Technology
	Penn State
	Pittsburg State University
	Pratt Institute
Purdue	
Roger Williams University	Roger Williams University
	Seminole State College of Florida
South Dakota State	
Southern Illinois	Southern Illinois
Southern Polytechnic State	
	Sundt San Diego
	SUNY College of Env. Science
	Temple University
Texas A&M	Texas A&M
Texas State	Texas State
University of Alaska	University of Alaska
	University of Akron
University of Arkansas	University of Arkansas
University of Central Missouri	University of Central Missouri
University of Cincinnati	
University of Florida	University of Florida
University of Houston	University of Houston
University of Louisiana, Monroe	
University of Maryland, Eastern Shore	

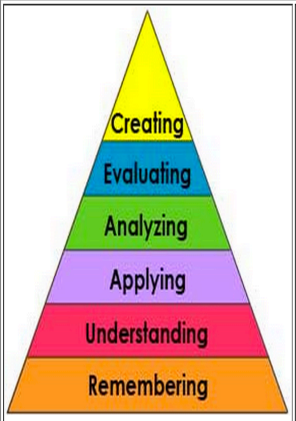
ACCE	AC Level 1
University of Minnesota, Twin Cities	
University of Nebraska, Lincoln	University of Nebraska, Lincoln
	University of Nebraska, Omaha
University of Nevada, Las Vegas	University of Nevada, Las Vegas
University of New Mexico	
University of North Florida	University of North Florida
University of Oklahoma	University of Oklahoma
	University of Southern Maine
University of Southern Mississippi	
	University of Toledo
	University of Texas, El Paso
University of Texas, San Antonio	University of Texas, San Antonio
University of Washington	
	University of West Florida
University of Wisconsin-Stout	University of Wisconsin-Stout
Virginia Tech	
Washington State	Washington State
	Wayne State University
Weber State	Weber State
Wentworth Institute of Technology	
Western Carolina	Western Carolina
Western Kentucky	

ACCE Certified Programs = 73 # AC Level 1 Certification Participating Programs = 69

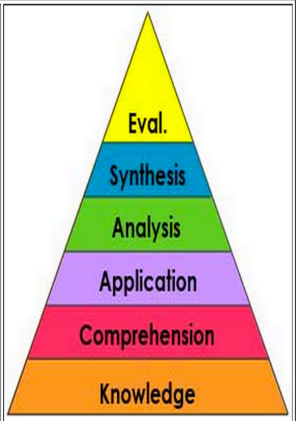
ACCE (63%) & AC (66%) Common Programs = 46

APPENDIX E

Blooms Taxonomy, Updated by Lorin Anderson (1990)

<table>
<tr>
<td> 

New Version</td>
<td>In 1956, Benjamin Bloom headed a group of educational psychologists who developed a classification of levels of intellectual behavior important in learning. During the 1990's a new group of cognitive psychologists, lead by Lorin Anderson (a former student of Bloom), updated the taxonomy to reflect relevance to 21st century work. The two graphics show the revised and original Taxonomy. Note the change from nouns to verbs associated with each level.

Note that the top two levels are essentially exchanged from the traditional to the new version.</td>
<td> 

Old Version</td>
</tr>
<tr><td>Remembering: can the student recall or remember the information?</td><td colspan="2">define, duplicate, list, memorize, recall, repeat, reproduce state</td></tr>
<tr><td>Understanding: can the student explain ideas or concepts?</td><td colspan="2">classify, describe, discuss, explain, identify, locate, recognize, report, select, translate, paraphrase</td></tr>
<tr><td>Applying: can the student use the information in a new way?</td><td colspan="2">choose, demonstrate, dramatize, employ, illustrate, interpret, operate, schedule, sketch, solve, use, write.</td></tr>
<tr><td>Analyzing: can the student distinguish between the different parts?</td><td colspan="2">appraise, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test.</td></tr>
<tr><td>Evaluating: can the student justify a stand or decision?</td><td colspan="2">appraise, argue, defend, judge, select, support, value, evaluate</td></tr>
<tr><td>Creating: can the student create new product or point of view?</td><td colspan="2">assemble, construct, create, design, develop, formulate, write.</td></tr>
</table>

APPENDIX F

Curriculum Vitae

Lana Kay Coble, Ed.D, CPC
Project Executive

Tellepsen, 777 Benmar Suite 400, Houston, Texas 77060
Mobile: 832.250.7423 • E-Mail: lcoble@tellepsen.com• http://www.coblescorner.com

Ms. Coble has gained *35* years of professional experience. Her industrial experience involves 12.5 million square feet of usable facilities, totaling over *$1.195 billion* dollars. Her projects included a major 25-story hospital in the Texas Medical Center, implosion/demolition of major buildings, technology-based data centers, retail, public sporting facilities, higher education and infrastructure systems. Her expertise includes training/education, implementation of software systems, development of document management systems, complex program management, and planning/scheduling mitigation on high profile construction projects. She has also been an advocate for community programs, women's development in the construction industry and mentorship of her staff and students. As a native Houstonian, Ms. Coble's enthusiasm and passion for her profession and education has touched many in Greater Houston area.

Education

Ed.D.	Education, University of Houston, Houston, TX	2015
M.S.	Architecture, Texas A&M University, College Station, TX	1980
B.A.	Construction & Design, Trinity University, San Antonio, TX	1978

Certifications

CPC	Certified Professional Constructor, American Institute of Constructors	2012

Employment History

- Tellepsen, Project Executive, Houston, TX. 2012-Present
- University of Houston, Associate Professor, Undergraduate Coordinator, Construction Management Dept., Houston, TX. 2011-2012
- University of Houston, Adjunct Faculty, College of Technology, Construction Management Dept., Houston, TX. 2009-2011
- Broaddus & Associates, Vice President Operations, Houston, TX. 2004-2011
- Tellepsen, Sr. Project Manager & Scheduling Director, Houston, TX. 1997-2004
- Fiesta Mart, Director of Maintenance & Construction, Houston, TX. 1988-1997
- Tribble & Stephens, Vice President, Houston, TX. 1980-1988
- Superior Homes, Designer, Houston, TX. 1975-1980

Highlights of Educator Experience

- **University of Houston-Construction Management Program, Houston, Tx.**
  - Associate Professor, Construction Management Program, University of Houston
    Undergraduate Student Coordinator
    Curriculum development and classroom instruction
    - Freshman Level Course – Introduction to Construction Management
    - Jr. Level Course – Construction Planning & Scheduling
    - Jr. Level Course – Construction Internship
    - Sr. Level Capstone Course – Construction Project Acquisition & Proposals

    Committee Chair
    - Construction Management Faculty Search & Recruitment
    - Construction Management Branding, Marketing & Recruitment
    - Construction Management Alumni Outreach & Social Media

    Committee Co-Chair
    - ACCE Accreditation Curriculum Standards & Reporting

- ACE Mentorship Organization, Board Member 2011-2012
- EWGA National, Business Woman of the Year Finalist 2011
- Texas Construction Outstanding Achievement Award, The Methodist Outpatient Center 2011
- Chain Store Executive Award, National Best Grocery Store of Year (Design and Construction), Fiesta Mart Blalock 1991
- Corum Development, Commitment Award, Completion of Projects within Schedule and Under Budget 1985
- City of Houston Most Improved Center of Year (Design and Construction), Briarcroft Center 1987
- Dean's List- Texas A&M University 1980
- Dean's List- Trinity University 1978
- Gamma Chi Delta, Best Active Award 1977
- Architectural Condominium Design Award, 2nd Place 1977
- Shriners Scholarship – Cy Fair High School 1974
- Cy-Fair High School, Miss Sportsmanship of the Year Award 1974
- Cy-Fair High School, Magna Cum Laude Award 1974
- Texas State Drafting Design Competition, 2nd & 3rd Place 1974

Professional Memberships

- American Institute of Constructors, National, Educator Member 2011-Present
- Construction Industry Institute, International, Honorary Member 1995-1996
- Construction Specifications Institute, International, Member 1995-1996
- Association of General Contractor, National, Honorary Member 1994-1996
- Society of Women Engineers, National, Member 1992-1993
- American Business Women's Association, National, Member 1992-1993
- Women in Construction, National, Member 1992-1993

Presentations and Program Development

- **Keynote Speaker, NAWIC South Central Region Annual Planning Conference, Breaking New Ground**
  - 35 Years of Women in Construction: Communication, Collaboration, Connectivity 2015
- **Panelist, for Women in Construction Industry Event for Junior High and High School Girls Sponsored by NAWIC and San Jacinto College** 2015
- **Keynote Speaker, Texas State Facilities Management Conference**
  - Project Delivery Processes Designed for Facilities Management for the University of Houston 2012
- **Doctoral Portfolio, Education-Curriculum & Instructional Design-University of Houston** 2012-2015
  - IRB Approval – Doctoral Dissertation – Analysis Of Undergraduate Student Success On The National AC Level 1 Certification Exam
  - Presentation: Texas State Facilities Management Conference – Project Delivery Process
  - Presentation: Study Project Management Knowledge of Construction Professionals: Cross

Country Study of Effects on Project Success (Chou, Irawan, and Pham, 2013) Structural Equation Modeling

- Presentation: Internet Surveys: Evolution as a Research Mode
- Presentation: Diversity-Current Issues, Educational Theory, & Faculty Implications
- Research Proposal: Construction Videography uses for Classroom Learning
- Educational Video Productions
  - The Art & Science of Construction Management
  - Construction Management Student Interviews
  - Construction Management Alumni Interview
  - TWU Health Science Center Schedule Mitigation Case Study
  - Construction Equipment at Work
  - Tutorial on Manual Calculation of Construction Line of Credit
  - Tutorial on Construction Future & Present Value Calculations
  - Tutorial Primavera P6 – Enterprise Structure Set up
  - Tutorial Primavera P6 – WBS Structure
  - Tutorial Primavera P6 – Layout View
  - Tutorial Primvera P6 – Activities, Durations & Relationships
  - Tutorial Primavera P6 – Filters
  - A Journey to Understanding Web 2.0 & It's Influence on Education
  - Introduction to Wiggio
  - Introduction to MindMeister
  - Introduction to Mendeley
  - Introduction to Quizlet

- **Tellepsen, Houston, Tx.** 2013-Present
  - Curriculum Developer & Instructor
    - Scheduling Specification and training program with reference manual
    - Monthly Cost Reporting
    - Project Manager Training Program
  - Development of Company Wide Project Scheduling Standards

- **Interagency Mentor Protégé Program** 2013-Present
  - Curriculum Developer & Instructor
    - Request for Proposal by Minority Firms to City Agencies
    - Interview Presentation Skills

- **University of Houston-Construction Management Program, Houston, Tx.**
  - Associate Professor, Construction Management Program, University of Houston 2011-2012

    Undergraduate Student Coordinator

    Curriculum development and classroom instruction
    - Freshman Level Course – Introduction to Construction Management
    - Jr. Level Course – Construction Planning & Scheduling
    - Jr. Level Course – Construction Internship
    - Sr. Level Capstone Course – Construction Project Acquisition & Proposals

    Committee Chair
    - Construction Management Faculty Search & Recruitment
    - Construction Management Branding, Marketing & Recruitment
    - Construction Management Alumni Outreach & Social Media

    Committee Co-Chair
    - ACCE Accreditation Curriculum Standards & Reporting
    - College of Technology/Construction Management Curriculum Standards

    Committee Member
    - Scholarship & Fellowship
    - University of Houston – Women's Commission

    Master's Thesis Defense Reviewer

- Adjunct Professor, Construction Management Program, University of Houston 2009-2011
  Curriculum development and classroom instruction
  - Sr. Level Capstone Course – Construction Project Acquisition & Proposals
  Committee Member
  - ACCE Inaugural Accreditation – Construction Management Program

- **Broaddus & Associates, Houston, Tx.** 2004-2011
  - Program Director B&A University
    - Online Learning Center
    - Weekly Employee Training & Development via Go To Meeting
  - Program Developer for SharePoint Document Management System
  - Program Co-Developer for Texas Medical Center Hurricane Preparedness Plan

  - Annual Conference Presentations
    - Hurricane Preparedness Plan
    - Implosion Lessons Learned
    - Major Capital Project Budget Management
    - Schedule Mitigation Case Study – TWU Project
    - 3D Modeling Software
    - B&A University Program
    - Major Capital Project Value Engineering Processes
    - Tower Crane Jacking Process
  - Training Manual & Instructor for University of Houston FP&C, B&A, M.D. Anderson Cancer Center, "How to Develop and Critique a Construction Program Schedule"
  - Construction Project Delivery Systems and Process Manual for University of Houston Facilities Planning and Construction
- **Tellepsen, Houston, Tx.** 1997-2004
  - Program Director Project Management Software, Constructware
    - Customization of Software
    - Development of Training Manual & Implementation
    - Instructor and Administrator of Constructware Software
  - Program Developer for Business/Technical Library
  - Program Developer for Continuous Process Improvement & Document Management
  - Program Developer for Policies/Procedures
  - Program Developer and Administrator of New Employee Orientation
  - Program Developer and Administrator of Employee Training & Development
  - Training Manual & Instructor for "EPA Environmental Reporting for Construction Projects"
  - Training Development & Instructor for "How to Implement E-Mail Services" for Tellepsen Employees
- **University of Houston-Construction Management Program, Houston, Tx.** 1995-1996
  - Curriculum development and classroom instruction
    - Construction Estimating
    - Construction Scheduling
- **Fiesta Mart, Houston, TX.** 1988-1997
  - Chair, Stewardship Management Committee
  - Program Developer, African American Product Marketing
  - Program Director Construction Manager @ Risk Operations
  - Program Developer Store Prototype and the impact on all Dept.'s.
  - Training Design and Implementation, Store Managers and Construction
  - Speaking Engagement, Society of Engineers, Junior Career Day
  - Speaking Engagement, American Subcontractor's Association, Women in Construction
  - Speaking Engagement, American Business Women's Association, Women Competing in

Business

- Speaking Engagement Panelist, Society of Women Engineers, Women in Engineering
- Speaking Engagement, University of Houston, Graduate Student Career Day
- Speaking Engagement, NAWIC Women in Construction, Breaking the Glass Ceiling

- **Tribble & Stephens, Houston, TX.** 1980-1988
  - Chair, Cost Analysis Committee & Program Development
  - Chair, Corporate Development Committee
  - Program Director Employee Training & Development
  - Chair, Computer Operations & Analysis Committee
  - Program Director of Legal Operations for Project Managers
  - Training Presentation to the AGC & Women in Construction, Lien Laws

Collegiate Teaching Student Evaluation

Item #	Item	Course CNST 1361 Coble's Section 17769 Mean	Course CNST 3331 Coble's Section 20651 Mean	Course CNST 4331 Coble's Section 17622 Mean	College Statistics Mean*
		N = 31	N = 37	N = 35	N = 2944
4	Instructor presentation of material	4.52	4.30	4.50	3.95
6	Instructor organization	4.35	4.22	4.51	4.03
7	Instructional effectiveness	4.45	4.24	4.54	3.96
11	The overall teaching effectiveness of this instructor is	4.26	4.19	4.63	3.89

Figure 1. Fall 2012, University of Houston-Construction Management Program, Mean = 5 point scale*

Sample Student Comments

- Comment #1-CNST 1361

  Overall, I have to give credit to Lana for exceeding my expectations with the presentation of this class. I have a little field experience so I expected topics such as safety, to be completely over-redundant, but I actually found myself involved in even these most basic topics. Great Job.

- Comment #2

  Ms. Coble brings in her own personal experiences from the field into the classroom to better explain certain situations.

- Comment #3

  Professor Coble is a excellent instructor she is great in what she does and im looking forward to seeing her again in the future.

- Comment #4

  Ms. Coble is wonderful in her delivery of material and engaging her audience.

- Comment #5

  Lana Coble has extensive knowledge of Architecture and Construction. She is a masterful instructor.

- Comment #6

Professor Coble is a great instructor for the University of Houston and is probably my most influential professors I have ever had.

- Comment #7

  Lana Coble is great. She loves what she does, and it shows. She brought us to the Cougar Village II site, and that was an extremely valuable experience, and it's something that no other class has provided me with.

- Comment #8

  She was an amazing professor. She made sure that we all understood what she was talking about. She kept the class interesting, and used humor to keep us awake and aware.

- Comment #9-CNST 3331

  The overall listening of the instructor and the adjustments when people were a little lost.

- Comment #10

  The professor's attitude was wonderful.

- Comment #11

  Lana is an awesome teacher. She is always very fast to respond to Emails, which is something that is not common. She truly cares about the students, this is very obvious.

- Comment #12

  Great teacher and she offers great resources outside the class to learn such as YouTube videos and office hours.

- Comment #13

  Lana is a very compassionate teacher and you can tell she cares about her students. Great teacher!

- Comment #14

  One of the best instructors in the program. Great to have someone with direct industry experience.

- Comment #15

  The way the instructor teaches with the desire to help us instead of intimidate us. Feels like a mom figure motivating us to succeed. Will redo her whole lesson if students do not understand. Has enormous respect for students.

- Comment #16-CNST 4331

  I really like Lana's organization. She is very clear on her presentations, on her online material and very, very good when it comes to respond to student issues. She is always ready to help with any issue ... excellent class.

- Comment #17

  Overall Prof. Coble is a great professor and her desire to go above and beyond shows the output of her students. She is a great asset to this program due to her networking and vast knowledge of the industry. She has what it takes to get this program to the next level!...Job well Done!

- Comment #18

  I loved Prof. Coble bringing in real world situations to the class. Also going above and beyond scheduling field trips and seeing a project in life away from the classroom is truly great!

- Comment #19

  AIC preparation was outstanding. Some of the material is very hard to get through but Lana connected with the students by taking us on field trips and requiring us to do a bid presentation.

- Comment #20

  Prof. Coble teaching! Hands down she's a great teacher and she made the best effort to make us learn the material at hand.

- Comment #21

  The opportunity to learn skills that enhanced my personal development.

Research Experience

- Analysis Of Undergraduate Student Success On The National AC Level 1 Certification Exam — 2012-2015
- Professional Construction Certifications – Survey and Factor Analysis — 2013
- Masters Thesis-Tilt Wall Construction Methods — 1980

Select Construction Projects

K-12 Education
- DeBakey High School, Houston I.S.D., 182,000 SF, $42M, Houston, Texas
- Milby High School, Houston I.S.D., 380,000 SF, $40M, Houston, Texas

Higher Education
- Plant Operations (Facilities management and Facilities Planning & Construction) – Project Process Development & Implementation, University of Houston, Houston, Texas
- Schedule Mitigation for Cougar Village Dormitory, University of Houston, 292,000 SF, $42M, Houston, Texas
- Schedule Mitigation for School of Business Curtain wall Re-cladding, University of Houston Clear Lake Campus, $2M, Houston, Texas
- University of Houston University Center Renovation Scheduling, $80M.
- University of Houston Cougar Village II and Cougar Place II dormitory scheduling, $50M and $49M respectively.
- University of Houston Robertson Stadium scheduling, $105M.
- University of Houston Scheduling Training for Plant Operations Personnel, Houston, Texas
- Institute of Health Sciences, Texas Woman's University, 196,000SF, $39M, Houston, Texas
- Nursing School, Prairie View A&M University, 582,500 SF, $32M, Houston, Texas

Healthcare / Laboratory / Research
- University Health System Hospital Expansion, 950,000 SF, $750M, San Antonio, Texas
- Institute of Health Sciences, Texas Woman's University, 196,000 SF, $39M, Houston, Texas
- Nursing School, Prairie View A&M University, 582,500 SF, $32M, Houston, Texas
- Northwest Diagnostic Clinic, Houston, Texas
- Outpatient Center, The Methodist Hospital, 1.6 million SF, $345M Houston, Texas

Industrial/Refinery
- Marathon Refinery-Central Control Building, 74,000SF, $42M, Texas City, Texas
- Samson Products-Valve Manufacturing Facility, 40,000 SF, $7.4M, Baytown, Texas

Infrastructure
- Roadway, Public Storm Retention Structures and Water Treatment Plant, Various Retail Projects, League City & Houston, Texas
- *Institute of Health Sciences, Texas Woman's University, Texas Medical Center, Houston, Texas*
- *UTMB Campus, Hurricane Ike Replacement of Thermal Distribution Elevated Utilities, Incinerator Disposal Equipment Replacement, New Heating and Hot Water Building, and Open Cut/Boring Underground Utilities, $83.5M, Galveston, Texas*
- *UTMB Campus, East CHP Plant (Gas and Steam Turbine Engines, Blackstart Generator, Heat Recovery Steam Generator, Thermal Energy Tank) and Underground Open Cut Underground Utilities to provide redundant services, 65,700 SF, $57.7M, Galveston, Texas.*

Medical Office
- Physician Relocation Projects – Smith & Scurlock Tower, The Methodist Hospital, 103,000 SF, $10M, Houston, Texas

Public
- Reliant Stadium, Houston Texans, Houston, Texas – Preconstruction Scheduling
- Memorial City Mall, Metro National Corp., Houston, Texas, 1.7 Million SF, $140M Construction, Houston, Texas
- Bobcat Stadium – West Expansion, Texas State University – San Marcos, 46,000 SF, $17.2M, San Marcos, Texas

Data Center
- Data Center, The Methodist Hospital, 30,000 SF, $14M, Houston, Texas

Religious
- Lakewood Church Renovation, Houston, Texas
- Unity Church, Houston, Texas

Public Housing
- The Terrace at West University, Houston, Texas
- Jacques Dujarié Residence Hall, St. Edward's University, 65,000 SF, $12M, Austin, Texas
- Wheeler Housing Project – Schedule Review and Preparation, University of Houston, Houston, Texas

Residential
- Weiss Residence/The Huntingdon High-rise Condominiums, Houston, Texas

Retail
- Multiple Randall's & Kroger Supermarkets, Houston Metroplex, Texas
- Memorial City Mall, Metro National Corp., $140M Construction, Houston, Texas

Decoupling, Demolition & Implosion
- Memorial City Mall, Metro National Corp., $140M Construction, Houston, Texas
- Outpatient Center, The Methodist Hospital,, $10M Houston, Texas
- HMB Implosion, M.D. Anderson Cancer Center, $19M, Houston, Texas

Professional Development

• Oracle University, Administration in P6 & Web Access	2010
• Oracle University, Project Management in P6 Release 7.0	2010
• Oracle University, Advanced Project Management in P6 Release 7.0	2010
• MP3 Estimating Software Training	2000
• Constructware Online Project Management Training	2000
• Aquent Partners, Presentation Skills Training	2000
• American Management Association, Instruction Design for Trainers	1999
• American Management Association, Train the Trainers	1999
• Diversity Training, Pauline Lyttle, University of Houston	1998
• New Horizons, PowerPoint, Excel, Project & Access Training	1998
• Commint Technical Services, P3 & Expedition Training	1998
• Timberline Estimating Software Training	1987

Community Affiliations

- **City of Houston Office of Business Opportunity Advisory Board, Houston, TX.** 2013-Present
- **Interagency Mentor Protégé Program, Houston, TX.** 2013-Present
  - City of Houston
  - Port of Houston Authority
  - Houston Independent School District
  - Metro Transit Authority
- **Houston Women in Highway Construction, Houston, TX.** 2012
- **Women's Contractor Association, Houston, TX.** 2012
- **Executive Women's Golf Association, Houston, TX.,** 2003-2012
  - Immediate Past President, Board of Directors
  - President, Board of Directors
  - Vice President, Board of Directors
  - Publicity & Marketing Committee Chair
  - Chapter and Regional Golf Tournament Director
  - Annual Gala Committee Chair
- **Heights Chamber of Commerce** 1991-1996
- **The Houston Center, Houston, TX., Non Profit Health Agency** 1987-1991

- Vice President, Board of Directors
- Director of Facilities
- Director of Educational Volunteer Program and Training Design
- Bereavement Counselor
- Community Outreach and Transportation Committee's

- **Gamma Chi Delta, San Antonio, TX.** 1976-1978
  - Director of Community Services
  - Historian

- **Anchor Society, Houston, TX., Founding Member Service Agency** 1973-1974

- **Women's Athletic Association, Houston, TX., Founding Member** 1972-1974
  - Vice President

- **Homebuilding Society, Houston, TX., Member** 1972-1974

- **Industrial Arts Society, Houston, TX., Member** 1972-1974

Athletic Accomplishments

- EWGA Lone Star Cup Competition Team Champion 2006, 2009
- EWGA National Golf Championship, 4th Place 2008
- EWGA Houston Golf Chapter Champion 2008
- PBGN Houston Golf Chapter Champion 2007
- Trinity University, Women's Collegiate Softball Team 1977-1978
- Trinity University, Intramural Golf Champion 1975-1978
- Cy-Fair High School, Golf Team 2nd Place Regional Award 1974
- Cy-Fair High School, Tennis Team 1st Place Competition Awards 1972-1974
- Cy-Fair High School, Golf & Tennis Team Letter 1972-1974

Highlights of Industrial Experience

- **Tellepsen**
  - Project Executive for 113 Thousand square-feet of New Data Control & Industrial projects, Value $50 Million, 500 thousand square-feet of high schools for HISD (including a 5 story high school in the Texas Medical Center), Value $$93 Million. Utility projects include removal and reinstallation of chilled and hot water infrastructure for the UTMB campus in Galveston (post hurricane IKE) and construction of a new CHP energy plant on the east side of campus to provide redundant utilities to provide continuous service during the next hurricane event.
  - Project Controls Manager - Schedule Preparation for company-wide projects, specifically 86 projects within 8 months, average early completion 9 days ahead of schedule

    Cost Controls & Fee Management for 65 projects (company wide)
  - Diversity Development Manager of subcontracting firms
  - Educator for operational staff in the area of Project Controls (cost and scheduling)
  - Recruiting Project Staff (entry to mid-level experience)
- **Broaddus & Associates**
  - Program Director for 2 Million square-feet of New & Renovated Space, Value $413 Million
  - Schedule Mitigation for company-wide projects
- **Tellepsen**
  - Sr. Project Manager for 2.3 Million square-feet of New & Renovated Space, Value $172 Million
  - Schedule Preparation for company-wide projects
  - Key member for Technology, Marketing, Human Resources, Administration and Project Management
- **Fiesta Mart**
  - Director of Maintenance & Construction for 4 Million square-feet of New & Renovated Space, Value $220 Million
  - Annual Maintenance Budget $7.5 Million, Annual Capital Project Budget $19 Million
- **Tribble & Stephens**
  - Project Director for 4 Million square-feet of New & Renovated Space, Value $80 Million

Professional Activities, Awards and Recognition

• San Jacinto North Community College Construction Department Advisory Board	2015-Present
• AGC Diversity Committee Co-Chair	2015-Present
• American Institute of Constructors National Education & Program Committee	2014-Present
• American Institute of Constructors Journal Article Reviewer	2014-Present
• Interagency Mentor Protégé Program Outstanding Mentor Award	2013-Present
• City of Houston Office of Business Opportunity Advisory Board	2012-Present
• International Golden Key Honor Society	2012-Present
• Women's Contractor Association Board of Directors	2012-2013
• Joe & Lee Mountain Scholarship – University of Houston	2012
• E.E. & Myrtle Oberholtzer Scholarship – University of Houston	2012
• ABC Student Chapter Faculty Advisor	2012
• University of Houston, Construction Management Faculty of the Year Award	2012
• AGC & ABC Student Chapter Faculty Advisor	2011-2012
• University of Houston, College of Technology, Construction Management Advisory Board for Industrial & Commercial Construction	2011-2012 2011
• EWGA National, Leadership Award Finalist	2011-2012